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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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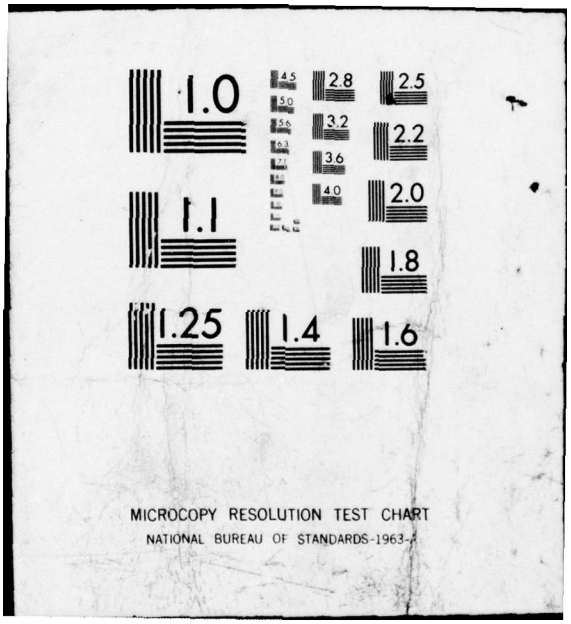
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Columbia-North Pacific Region Comprehensive Framework Study APPENDIX II THE REGION

Columbia–North Pacific Region

Comprehensive Framework Study

of Water and Related Lands

APPENDIX II

THE REGION

SUBMITTED BY

PACIFIC NORTHWEST RIVER BASINS COMMISSION
1 COLUMBIA RIVER, VANCOUVER, WASHINGTON

JUNE 1969

This appendix is one of a series making up the complete Columbia-North Pacific Region Framework Study on water and related lands. The results of the study are contained in the several documents as shown below:

Main Report

Summary Report

Appendices

I. History of Study

II. The Region

III. Legal & Administrative Background

IV. Land & Mineral Resources

V. Water Resources

VI. Economic Base & Projections

VII. Flood Control

VIII. Land Measures & Watershed Protection

IX. Irrigation

X. Navigation

XI. Municipal & Industrial Water Supply

XII. Water Quality & Pollution Control

XIII. Recreation

XIV. Fish & Wildlife

XV. Electric Power

XVI. Comprehensive Framework Plans

Pacific Northwest River Basins Commission
1 Columbia River
Vancouver, Washington

The Region

APPENDIX II

Columbia-North Pacific Region
Comprehensive Framework Study
of Water and Related Lands. Appendix II.
The Region,

E. L. White, G. J. Gronewald,
H. H. Ralphs G. E. Van Santen

June 1969

164 p.

Submitted by

Pacific Northwest River Basins Commission
Vancouver, Washington

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This appendix to the Columbia-North Pacific Region Framework Report was prepared at field level under the auspices of the Pacific Northwest River Basins Commission. It is subject to review by the interested Federal agencies at the departmental level, by the Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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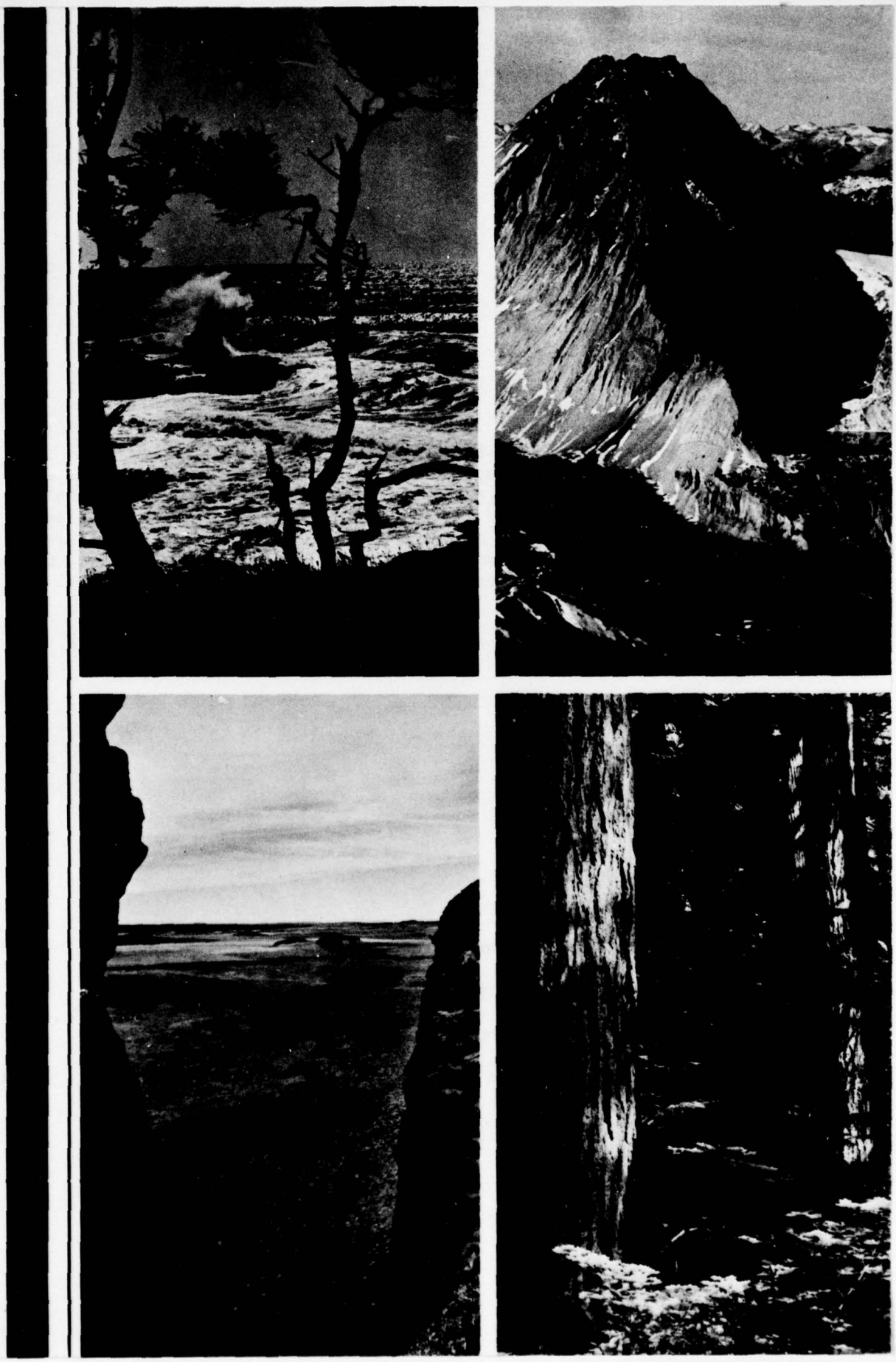

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COMPREHENSIVE FRAMEWORK STUDY

THE C-NP SUBREGIONS

1968

FIGURE 1

INTRODUCTION

PURPOSE

The purpose of Appendix II, The Region, is to give an overall view of the history of the Columbia-North Pacific Region and describe its geology, climate, natural resources, and population characteristics. A description is also provided for each of the twelve subregions into which the region has been divided for study purposes. This description covers two types of information: general information that could be fitted into any one of several appendices, and additional detail needed to more fully describe the region.

The coverage in this appendix is not intended to be an all inclusive regional description. Details concerning the functional aspects of water use, as well as detailed inventory information, have been fully and adequately covered in the several appendices listed inside the front cover of this volume.

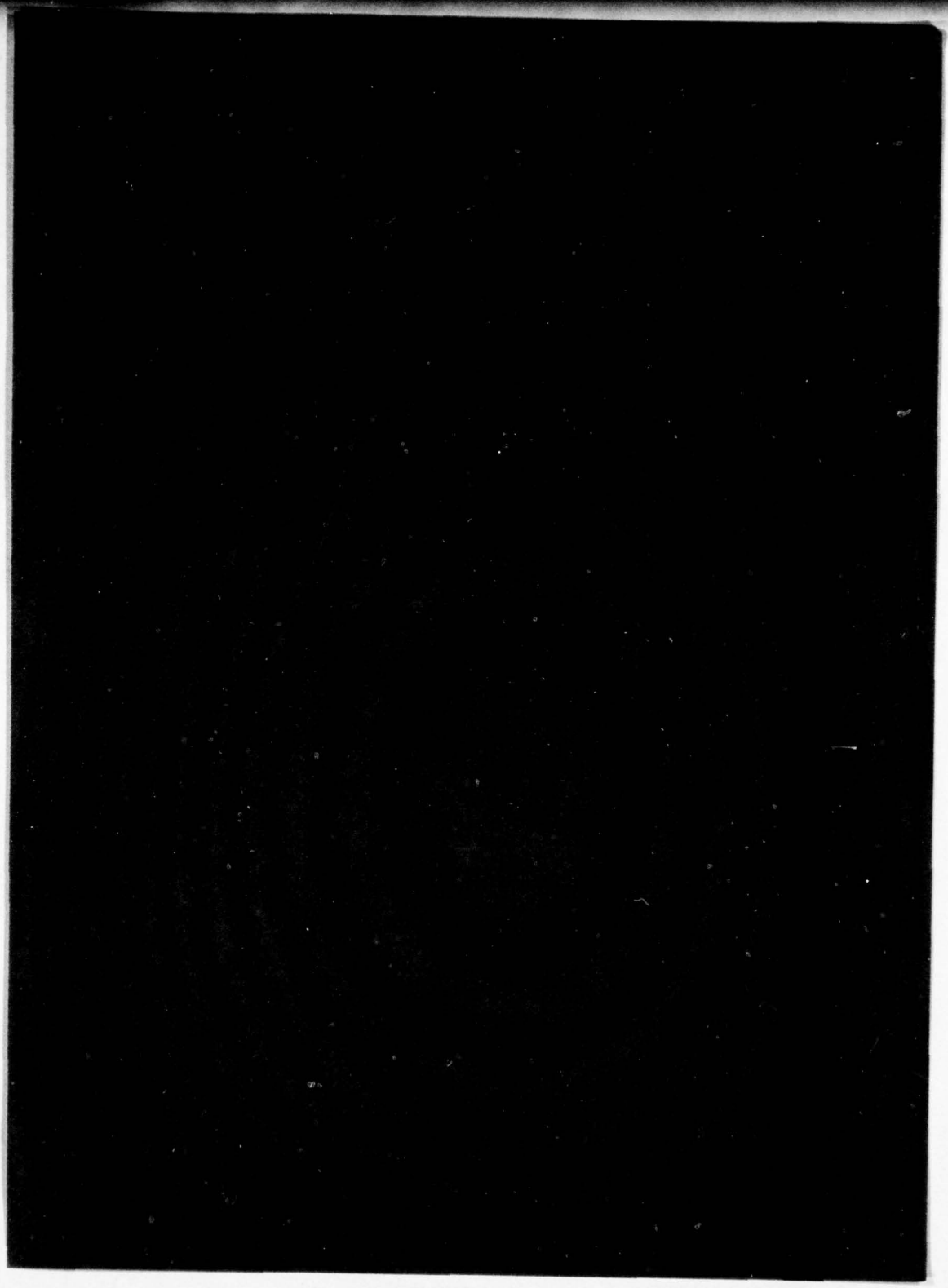
LOCATION AND SIZE

The Columbia-North Pacific Region, as defined for purposes of this water resource study, occupies about 274,400 square miles of the northwestern corner of the conterminous United States, commonly known as the Pacific Northwest. The region includes all of the Columbia River Basin in the United States, those basins in Oregon and Washington draining into the Pacific Ocean, the Straits of Georgia or Juan de Fuca within Washington, and that part of the Great Basin lying in Oregon. Some 39,500 square miles of the upper Columbia River drainage lie in Canada and are not included in the study area.

The region encompasses all of the State of Washington, most of Oregon and Idaho, that part of Montana west of the Continental Divide, and portions of Utah, Wyoming, and Nevada that are drained by tributaries of the Columbia River. The area is slightly larger than the European countries of Belgium, Denmark, France, the Netherlands, and Switzerland combined and equal to almost 8 percent of the area of the conterminous United States. Of the 20 regions slated for study under the Water Resources Planning Act, it is the third largest, being exceeded only by the Missouri and Arkansas-White-Red.

On the east, the area is bounded by the Continental Divide

of the Rocky Mountains, on the north by the Canadian border, and on the west by the Pacific Ocean. Its southern boundary is the southern rim of the Snake River Basin and the Oregon State line, except the Oregon portion of the Goose Lake, Klamath, and Smith River drainages which are excluded. The study region is shown in Figure 1.



H I S T O R Y

EARLY CIVILIZATION

Wherever the early explorers landed on the shores of the Pacific Northwest, they were met by members of local Indian tribes. These people, of Asian extraction, numbered between 100,000 and 180,000 according to the first estimates. Concentrated along the coast, they had split into about 125 different tribes and countless smaller groups. Although similarities were noted in these tribes, they had developed different customs and levels of attainment in various aspects of utilizing the available natural resources.

No forms of agriculture had been developed other than the encouragement of some plants through harvesting techniques. The dog was the only domesticated animal until horses became important shortly before 1800. Natural fauna and flora obtained by crude hunting, fishing, and gathering methods provided the Indians' only sources of food (3-5). One of the principal sources of food was the salmon, caught as they ascended the streams to spawn. Reports by early explorers indicate that upwards of 50,000 Indians lived along the Columbia and Snake Rivers, concentrated at the major falls and rapids where they fished with dip nets and other means (2-6).

The Indians had well developed religious and political systems and a complex cultural heritage. Tribal organization was variable and dependent upon the population density. In the arid areas the groups were small and scattered with little organization while along the coast large groups lived in close proximity with complex tribal organization.

The Indians had developed a wide range of simple hand tools to aid in their daily life. In addition, tribes along the coast utilized the abundant timber to build communal houses from split cedar planks. Forms of art expression were varied and developed by some tribes to a high degree.

With the first white men came European diseases to which the Indians were not immune and a large percentage of some tribes died within a short time. Permanent settlers soon followed and reaction to the settlement of tribal lands resulted in several short but bloody wars. At their conclusion reservations were created and the Indians were placed on them. These two factors, combined with a change from subsistence living to dependence on trading with the white man, caused a great change in the organization, culture, and

customs of the Pacific Northwest Indians during the 1800's.

DISCOVERY AND EXPLORATION [1/]

The Japanese were the second known people to reach the Northwest. They appeared as survivors of shipwrecks which had drifted across the North Pacific and south on the California current to the Oregon and Washington coasts. Their only contributions were a few artifacts and a place in Indian legends.

Perhaps the first European to reach the region was Juan Cabrillo, a Spanish explorer who may have sailed as far north as the southern Oregon coast in 1542. English explorers entered the Pacific in 1578, and Drake continued northward to possibly the 48th parallel in 1579, after raiding the rich Spanish ports of western Latin America. Late in the sixteenth century, Spanish explorers renewed their interest in the Pacific Northwest. By 1594, Spain had begun a systematic exploration of the northwest coast. Martin Aguilar traveled along the coast in 1602-1603, but exploration then progressed little for nearly two centuries.

In 1774, Juan Perez sailed north, as a deterrent to Russian expansion, to claim the entire coast for Spain. His descriptions of the Oregon and Washington coasts were not detailed, but he did reach Vancouver and Queen Charlotte Islands. The following year he was the pilot for a party which claimed portions of the coast. Heceta, one of the captains, discovered the Columbia estuary and named it Assumption Bay. However, his crew had been reduced, and he was unable to explore eastward and determine if it was a river. Within a few years, the voyages of Perez, Quadra, and Heceta defined the coastline, named prominent features, and gave Spain the basis for possession.

Quadra and Arteaga surveyed the area again in 1779. Spanish exploration was thorough, systematic, and accurate, but reports were not published until years later. The British gained less information, but it was published immediately. Spain's early advantage was not pressed; even the place names have now largely disappeared.

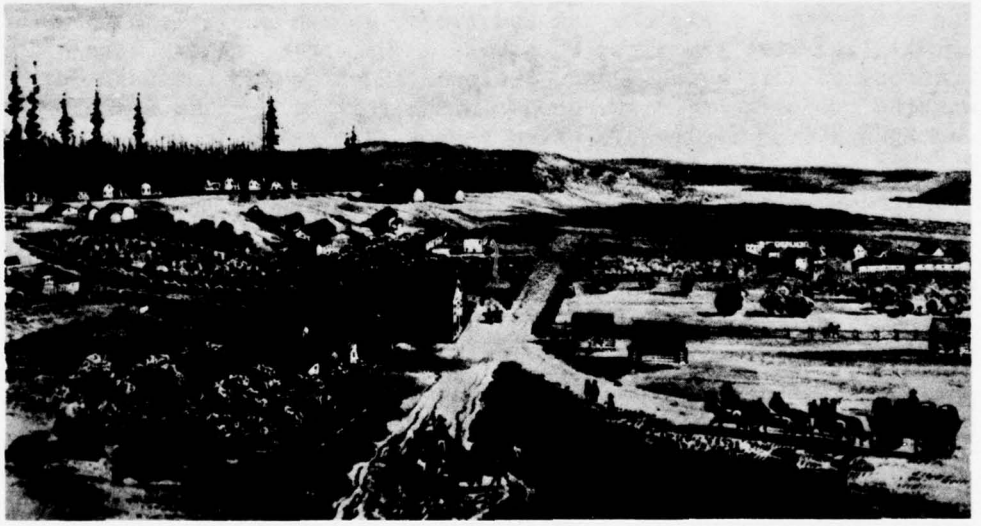
England's renewed interest in the elusive Northwest Passage at that time prompted a search from the Pacific side. James Cook sailed around Africa and on to the Northwest; his first landfall was near Yaquina Bay in March 1778. His mission was farther north, so little time was spent along the Oregon and Washington coasts.

1/ The principal source for this section was: Johansen, Dorothy O. and Charles M. Gates, Empire of the Columbia; A History of the Pacific Northwest. Harper & Brothers, New York, 1957.

On August 9, Cook sailed through Bering Strait and determined that a Northwest Passage could not exist.

The fur trade began in earnest during the 1780's, bringing more visitors to the region. Barkley rediscovered the Strait of Juan de Fuca and, in 1787, Meares identified new points along the Oregon and Washington coasts. Details of the bays, inlets, and estuaries were mapped in 1792. Captain Vancouver and Lieutenant Puget charted the coast and Puget Sound. Captain Robert Gray, the first American trader, entered the Columbia River and explored the lower reaches, but did not take possession for the United States.

Overland exploration did not begin early because of the vast unexplored wilderness between the region and the populated eastern seaboard. Even before completing the Louisiana Purchase, President Jefferson, who had long maintained an interest in the West, organized the expedition headed by Captains Meriwether Lewis and William Clark to explore up the Missouri River and on to the Pacific Ocean. Their journey to the west began from St. Louis in May 1804. In August 1805, they crossed the Lemhi Pass and entered the Columbia Basin, eventually traveling down the Clearwater, Snake, and Columbia Rivers to the Pacific Ocean. After wintering near Astoria, they returned east taking information on geology, soils, plant and animal life, native inhabitants, and agricultural possibilities. The enthusiasm expressed by Lewis and Clark for the Oregon Country fired the imagination of easterners and people began moving west.



Fort Vancouver from the Northwest, 1854, drawn by Gustavus Sohon. From U. S. War Department, Reports of Explorations and Surveys, to Ascertain the most practicable and Economic Route for a Railroad from the Mississippi River to the Pacific Ocean, vol. XII, Plate XLIV. (National Park Service photo)

Soon traders and trappers, both Canadian and American, were entering the region. The Pacific Fur Company, headed by John Jacob Astor, established Fort Astoria as a trading post in 1811. Disasters, poor management, and the War of 1812 caused the establishment to pass into British hands and be renamed Fort George. In the hands of the North West Company, trade was further expanded into the Upper Columbia and the Snake Basins. The post passed to Hudson's Bay Company in 1821 and, for strategic reasons, it was moved inland and renamed Fort Vancouver in 1825.

Inland trade developed very rapidly in the 1820's. Men such as Donald McKenzie and Peter Skene Ogden were among those trading for Hudson's Bay when John McLoughlin became Chief Factor at Vancouver. McLoughlin carried out extensive agricultural and trading innovations. By the early 1830's cattle and sheep were grazing on Wapato (Sauvie) Island, as well as around the fort.

David Douglas, the noted Scottish botanist, opened a new phase of exploration with his scientific treks in 1825-27 and 1830-32. He discovered and classified several hundred plants, including the Douglas-fir, which was subsequently named after him. During this period, many traders and trappers were traveling in the interior. Jedediah Smith and others traversed much of what now is the Western United States in their quest for fur. Captain Bonneville drew further attention to the Northwest when he brought goods in by wagon. This suggested to many people the possibility of settlement by overland routes.

By the middle 1830's exploration was largely completed, the beaver had become scarce, and settlement was beginning. During the period of exploration and trade, Indian societies and animal life were experiencing severe adjustments. There were numerous factors which caused profound shock to the Indians. One was the profusion of trade goods in the form of cooking vessels, cloth, and iron implements which nearly eliminated local manufacture of goods. A second factor was the introduction of firearms, which began an era of internecine warfare and the consolidation to stronger tribal groupings. The development of an export economy was a third factor. With traders willing to buy furs, hides, etc., the cultural focus changed from subsistence living to providing trade items. A fourth, and perhaps more important factor, was the rapid spread of communicable European diseases. The mortality rate was directly related to population density. Some heavily populated areas lost the major percentage of their inhabitants in a very few years.

SETTLEMENT

In 1809, under David Thompson's direction, the first

trading post in the region was built on the eastern shore of Lake Pend Oreille. Within less than a year, it was abandoned. In 1810 or 1811, Spokane House was constructed near the present site of Spokane, Washington. Both of these were outposts of the North West Company, a principal fur enterprise. As mentioned previously, Astor's group founded Fort Astoria in 1811. This soon passed to British interests, who established other posts in the interior within the next decade.

Fort Vancouver, under the English leadership of Dr. John McLoughlin, was the first settlement around which large scale agriculture developed. By 1829, it was producing 2,000 bushels of small grains, in addition to maize, vegetables, fruit, and livestock. Agriculture spread to much of the region from this post. Retired Hudson's Bay employees settled as farmers in the Willamette Valley, raising crops and grazing livestock.

Fort Nisqually was established in 1833 as an agricultural settlement and shipping point. Early returns were poor, but by 1841 about 1,000 acres were in grain and potatoes. By that year, 77 persons had settled at Nisqually; many others began as independent farmers nearby.

During the early 1840's new settlers began to join those already in the Willamette Valley. Early missionary contributions to the settlement of the region were made by both Protestant and Catholic. In 1834, Methodists, headed by Jason Lee, established the first mission in the Willamette Valley. Two years later, Dr. Marcus Whitman and the Rev. Henry H. Spaulding, respectively, founded missions at Waiilatpu near *Walla Walla, Washington,* and at Lapwai, near Lewiston, Idaho. Catholic missionaries under Father Francois Blanchet arrived from Canada two years later and established missions throughout the Northwest.

Promoters who dreamed of Oregon as a bustling land covered by farms and towns propagandized the East, enticing settlers. By the late 1830's and early 1840's these agriculturists were beginning to arrive. The Indians began to react to the tide of settlers. This resulted in several massacres and wars that were temporary deterrents to settlement.

During this entire period, the questions of sovereignty were being settled. Spain had not pressed her earlier advantage. On the other hand, England and the United States remained as claimants. Russian claims had been nearly excluded by these two. By the agreement of 1818, England and the United States settled on joint occupation; this was extended for ten years in 1827. The United States claimed land to 54°40' north latitude, or at least to 51°. England wanted to retain the area north of the Columbia in the west and all of that north of the 49th parallel. The

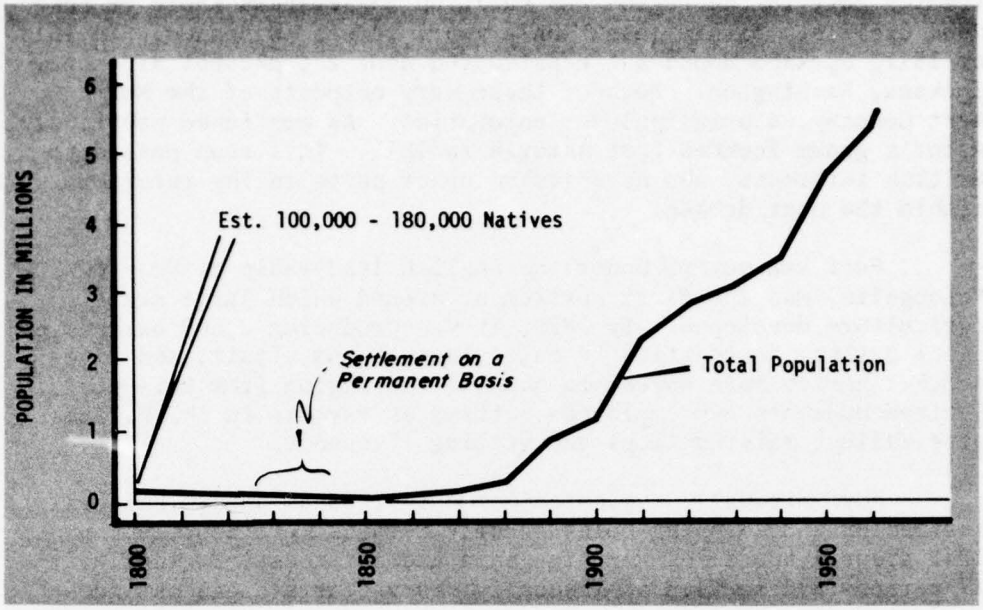


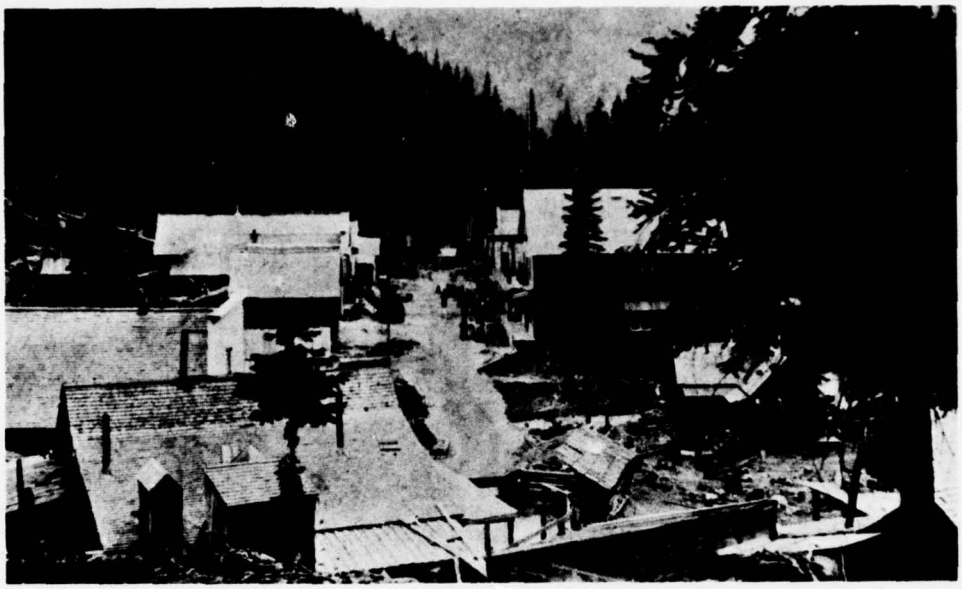
FIGURE 2. Population Trend in the Columbia-North Pacific Region
Extracted From: Census of Population, 1950 & 1960

Hudson Bay Company wanted to retain what is now eastern Washington, northern Idaho, and western Montana. Americans hoped to gain all the area south of the 49th parallel and encouraged settlement to achieve this end. In 1846, the Governments of the United States and England agreed on the 49th parallel as the northern boundary of the United States.

Population growth soon became more rapid. In 1846, there were less than 6,000 whites in the region, but the population grew to 13,000 by 1850. Most of these were in the Willamette Valley-Vancouver area.

The major objective of Federal policy, coinciding with that period of settlement in the Pacific Northwest, was to make lands easily and rapidly available for permanent occupation. It was generally held that benefits to be derived from permanent settlement were greater than consideration of maximum financial return from sale or lease of lands.

Practically all of the Columbia-North Pacific Region was originally public land of the Oregon Territory, and was thus subject to disposal, a fact which greatly influenced the settlement patterns of the region. The first attempt by Congress to open the Northwest to settlement was the passage of the Donation Land Act of 1850. This Act allowed existing married settlers to acquire



Bourne, Oregon, an early mining town of the Columbia-North Pacific Region. (Oregon Department of Geology and Mineral Industry)

title to 640 acres providing they occupied and cultivated the land for four years. Under this Act, some 7,400 settlers claimed in excess of 2.6 million acres in the fertile western Oregon valleys of the Rogue, Umpqua, and Willamette. As settlement continued in the western part of the region, it extended into the Puget Sound area and, in 1853, the Washington Territory was created. Oregon attained statehood in 1859.

Discovery of gold at several locations caused an influx of people to remote places. Changes in the economy soon followed; trapping became less important, while agriculture, mining, and fishing increased in importance.

Principal gold discoveries were made at Colville, Washington, and Jacksonville, Oregon, and along the Frazer River in British Columbia. Placer deposits were being worked in the Elk City, Idaho area by 1861. The 1860 gold strike along the John Day and Powder Rivers brought hordes of miners into eastern Oregon. Expanded markets for livestock in the mining areas prompted permanent occupation of adjacent rangeland for grazing purposes.

Under the 1862 Homestead Act and subsequent modifications, a large part of the public domain was settled by individuals and passed into private ownership. The early 160-acre homestead size

was reasonably adequate for subsistence and commercial farm development in the humid western part of the region. However, as settlement expanded into the semi-arid lands, 160 acres were insufficient for successful dryland farming, or year-round forage production, and many farming attempts led to failure. Although no individual rights could be acquired, stockmen grazed many thousands of sheep and cattle on the open range. This soon led to the use of the native forage at a rate much greater than natural production.

The discovery of gold, the Homestead Act, and other incentives for settlement brought an even greater increase in population. By 1870, white population in the Pacific Northwest had increased to about 135,000, with 91,000 in Oregon and 24,000 in Washington.

In the western part of the region many forest acres were patented under the Homestead Act. In 1873 the Timber Culture Act authorized any person who kept 40 acres of timber in good condition to acquire title to 160 acres. In 1878 the requirement was reduced to only 10 acres of good timber condition. In the developing timber industry, private acquisition of timber was encouraged, and the Timber and Stone Act was passed in 1878. This Act provided that surveyed lands in Oregon and Washington, valued principally for timber and stone and unfit for cultivation, could be purchased in quantities up to 160 acres at a minimum of $2.50 per acre.

The Desert Land Act of 1877 allowed each claimant 320 acres, provided part of the land was irrigated within three years. While successful in those areas where lands could be easily and cheaply irrigated, this program was generally inadequate for developing agricultural demands.

Under the Carey Act of 1894, each state could select one million acres of desert land that could be settled, reclaimed, irrigated, and cultivated. In many cases, reclamation projects undertaken by private companies under the Act were unsuccessful unless irrigation efforts were relatively inexpensive. This pointed to the need for public construction and financing, and the Federal Reclamation Act was passed in 1902. This Act provided for Federal construction of irrigation works with use of Federal Funds, and set up a reclamation revolving fund to which certain revenues from western lands accrued.

To encourage settlement and to develop transportation routes, a series of railroad land grants were made in the 1860's and 1870's. The railroads obtained the right-of-way and alternate sections of Public Domain land to finance construction. The grants varied in width from 10 to 30 miles on either side of the railroad. A large percentage of the lands acquired by railroads was in turn sold to

private enterprise at prices but slightly higher than lands sold by the Federal Government.

In the Pacific Northwest, railroad grants totaled approximately 14 million acres. It is significant from a settlement standpoint that 9.5 million acres were in the State of Washington (approximately 22 percent of the total Washington land area).

Washington and Montana became states in 1889, Idaho and Wyoming the following year. Upon attaining statehood, each State was granted lands by Congress for educational and other purposes. In all, approximately 14 million acres in the region were transferred to the States. Most of the State lands in Oregon were sold. Each of the other States retained about three-fourths of its land grant, most of which has been made available for agricultural and grazing leases.

Large railroad land grants and transcontinental railroad construction through the Pacific Northwest between 1880 and 1900 brought a new surge of homeseekers, settlers, ranchers, and laborers. Many of these new settlers established themselves in the semi-arid grasslands and easily irrigated lands of the region.

By 1900, the region's population had increased to approximately 1.2 million people. Meanwhile, there was an increasing public awareness that many of the resources were not unlimited and that there was need to conserve and control their use. Successive withdrawals were made to conserve Indian lands, timber resources, power sites, scenic wonders, grazing lands, and land for other public uses.

The first major area withdrawn from settlement was Yellowstone National Park, established in 1872 in the States of Wyoming, Idaho, and Montana. Subsequent legislation was enacted to withdraw and reserve public lands with forests, to assure protection of Federal timberlands and upland watershed areas. In 1891, the first National Forest Reserve was established and designated the Yellowstone Park Timberland Reserve.

The Bull Run Forest Reserve, which later became the Mt. Hood National Forest, was established in 1892. In 1893, additional reservations were made and included other areas in Washington and Oregon. Forest reserve withdrawals followed in Idaho and Montana in 1897. These reserves were later to become the national parks and forests.

In 1909, the Enlarged Homestead Act provided for the settlement of 320 acres when lands were suitable for dry farming but were not irrigable. Thus, many of the grazing lands where rainfall totaled 12 inches or more became dryland wheat producing areas.

The Weeks Act of 1911 authorized the Federal Government to purchase cutover timberlands for national forests. These were principally forest lands, but also included some of the earlier homesteads that had proven unsuitable for agriculture. This was probably the first reversal in the procedure of public land disposal to encourage settlement.

Farms, salmon canneries, and sawmills supported coastal towns from Coos Bay, Oregon, to Grays Harbor, Washington. Mining communities developed in northern Idaho, Montana, and southern Oregon. Spokane, Boise, Pendleton, Salem, Yakima, and Missoula developed as trading centers.

During the early settlement period the economy was primarily based on the conversion of natural resources into exportable products. Timber harvesting expanded vigorously, especially in Washington. Mining was not as important in Oregon and Washington as in Idaho and western Montana. The Coeur d'Alene lead, zinc, and silver district produced $400 million by 1917. The Idaho City area yielded a tremendous amount of gold. Copper developments around Butte yielded even greater wealth. Fishing, especially for salmon, on the region's major streams, expanded at a rapid rate after 1850 and reached its peak harvest during the 1880's. Ocean fishing too, was significant.

Seattle and Portland continued to be the largest cities, but Spokane and Tacoma were growing rapidly. Boise, Vancouver, Salem, Eugene, and many towns around Puget Sound were becoming small cities.

In 1916, the Stock Raising Homestead Act increased the acre limitation for homesteads to 640 acres when public lands were suitable only for grazing livestock. However, it is estimated that in some of the rangeland, as much as 8,000 acres were needed for an economic unit.

By 1920, the region counted 2.7 million people, a gain of over 450,000 in a decade. Oregon continued to grow during the 1920's, as additional timber resources were tapped. Lumber and lumber product manufacturing stimulated the development of small towns and villages in all the valleys where timber grew. In later decades, when the nearby old growth timber was gone or transportation improved, the hamlets were often abandoned, a trend that is continuing today. Cities grew as manufacturing and trade expanded. The agricultural resources continued to be developed.

Population had increased to approximately 3.1 million people by 1930. This included some 1.6 million in Washington, and almost 1 million in Oregon.

A few years later there were an estimated 14.4 million acres of cropland, about 77.6 million acres of non-forest rangeland, some 78.2 million acres of forestland, and 3.5 million acres of urban, industrialized, and barren land. Table 1 reflects this data and the ownership trends.

The Federal Government had withdrawn from entry about 73 million acres (42 percent of the land area), consisting largely of Indian reservations, mineral deposit land, parks, water power and reservoir sites, forest reserves, and grazing lands. An additional 27.6 million acres (15.9 percent) was vacant Public Domain. The States and counties owned about 12.3 million acres. The remaining lands (35 percent) were in private ownership.

During the 1930's, settlement patterns changed somewhat. Although farm incomes were low during this period of depression, some people remained on the land simply because there were no other jobs. In contrast, Government works, particularly dams and irrigation projects, resulted in towns being constructed where none had existed earlier. Population increased in all the States

Table 1 - Land Ownership and Use Trends
Columbia-North Pacific Region

	1934 [1]		1952 [2]		1966 [3]	
	Million Acres	Per Cent	Million Acres	Per Cent	Million Acres	Per Cent
OWNERSHIP						
Federal						
Reserved	72.8	41.9	95.0	54.7	95.6	55.0
Vacant	27.6	15.9	--	--	--	--
Total Federal	100.4	57.8	95.0	54.7	95.6	55.0
State	10.4	6.0	7.8	4.5	8.4	4.8
County & Municipal	1.9	1.1	0.2	0.1	1.0	0.6
Private	61.0	35.1	70.7	40.7	68.7	39.6
Total	173.7	100.0	173.7	100.7	173.7	100.0
LAND USE						
Cropland	14.4	8.3	18.4	10.6	20.8	12.0
Forest Land	78.2 [4]	45.0	84.4	48.6	85.8	49.4
Range	77.6 [5]	44.7	63.8	36.7	58.8	33.8
Other	3.5	2.0	7.1	4.1	8.3	4.8
Total	173.7	100.0	173.7	100.0	173.7	100.0

1/ Migration and the Development of Economic Opportunity in the Pacific Northwest, National Resources Planning Board, Region 9 Portland, Oregon, August 1939, pp. 99, 111 (data proportionally adjusted from total 188 million acres to present C-NP regional area).
2/ Agricultural Program Reports, Columbia River Basin Area, U. S. Dept. of Agriculture, preliminary report 1953 (data proportionally adjusted from total 174.5 million acres to present C-NP regional area).
3/ Appendix IV, Land & Minerals, 1969.
4/ Includes 5.8 million acres woodland pasture in farms.
5/ Includes 23.1 million acres nonwoodland pasture in farms.

during this period, especially Idaho and western Montana. In 1940, the regional population was about 3.5 million--nearly half in Washington, roughly a quarter in Oregon, and a quarter in the remainder of the region.

Two important currents were moving through the region during the 1940's. Wartime industries were attracted by the availability of large blocks of electric power. Shipbuilding and aircraft industries drew tens of thousands from the farms during the first half of the decade. These people migrated to the Portland-Vancouver and Puget Sound areas to work in the shipyards and to the latter area to work in the aircraft plants of Boeing; most stayed in these cities. The aluminum industry expanded rapidly in smaller cities along the Columbia River.

In addition to these industries, vast military training and ordnance facilities were built attracting even more people to these cities. After the war, the Columbia Basin Project and other irrigation developments east of the Cascades drew some people back to the land, but industry and improved transportation tended to encourage urban growth.

Shipbuilding in the Puget Sound and Portland ports declined very sharply after the war; however, the military-industrial complex from Bellingham through Seattle to Fort Lewis fostered urban growth along the eastern shore of Puget Sound. Virtually all cities grew during this period. By 1950, the region contained about 4.6 million people, an increase of one-third over 1940. By then, most of the population was classed as urban, although much of the eastern portion was still rural.

The decade of the 1950's marked a change from the recent past. Some industries weathered critical periods and their employment held constant; however, agricultural employment, due to mechanization, continued to decline. Services and residentiary industries continued to expand as cities grew. The recreation industry too, began to grow as people throughout the Nation were attracted by the region's abundance of prime recreational areas. (See section on Population Characteristics.)

With few exceptions, population patterns remained much the same. As a general rule, the coastal counties grew slowly, if at all. Much of central and eastern Oregon and parts of eastern Washington, Idaho, and Montana also remained static. However, the Puget Sound-Willamette Trough, Spokane, parts of the Snake Valley, and some portions of southern Oregon experienced significant growth. Population became more concentrated as people moved to the cities.

By 1960, the region's population was about 5.4 million, an

Urban land, an increasing important use of the land resources of the C-NP Region (Port of Seattle)

increase of about 18 percent over 1950. Urban population comprised about 63 percent of the total. In fact, 2.2 million or 40 percent were in the Seattle-Tacoma and Portland-Vancouver metropolitan areas. Only Idaho and western Montana remained with a minority living in cities. The estimated 1965 regional population was 5.9 million.

In 1966, about 95.6 million acres of the region remained in Federal ownership, while 68.7 million acres were reported in private ownership, and 9.4 million acres were in State or county ownership. At this time there was an estimated 20.8 million acres of cropland in the region; 85.8 million acres were in forest cover and 58.8 million acres were classified as non-forest rangeland; other land, rocky, barren, dunes, and urban areas amounted to 8.3 million acres. In turn, 7.3 million acres or 36 percent of the cropland was irrigated.

DEVELOPMENT

This section deals with the general development of the basic agricultural, forest, mining, transportation, power, recreation and fishing resources of the region. Their fundamental relationships to water are pointed out as they pertain to the region's development and prosperity.

Agriculture

Agricultural development began to blossom in the 1840's and grew from a supplier of food to the forts and missions to become a major segment of the historic and present economy, in

addition to being an important element in attracting permanent settlement.

Agriculture started in the Willamette Valley in the 1840's. Nearly all of the early farmers raised some cash crop to enable the purchase of items such as tools, salt, and cloth. Exports were grain and cattle, the former still comprising a major percentage of the agricultural exports. Wheat farming boomed in the Palouse area and in southern parts of the Columbia Plateau that had access to transportation routes via the Columbia River. In the interior, a distinctive form of agriculture, related to grazing livestock, became commonplace; large herds of cattle and sheep were grazed freely on the Public Domain lands. Fruit and grain farming were beginning in the yakima and Wenatchee Valleys and around Spokane, but did not prosper until much later. Idaho's agriculture, except in minor instances, had to await the coming of the railroads in the 1880's.

After the railroads were built, grain farming became feasible in many new areas. Locations east of the Cascades with adequate precipitation were planted in grain to satisfy the expanding eastern and European markets. Wheat was the principal export, but other small grains were significant. Large acreages of oats were harvested, but most of the crop went to feed draft animals.

From these early beginnings the use of land for crop production increased substantially in the Columbia-North Pacific Region. Mechanization of farming made possible larger land holdings and more efficient operations. This also made possible the adoption of new techniques relating to rotations, residues, and tillage, and allowed the introduction of cultivated crops into areas formerly considered too dry.

The 1964 Census of Agriculture reported 4.7 million head of cattle and calves, 1.8 million sheep and lambs, and slightly less than half a million hogs in the region. Dairy cattle are concentrated in the area west of the Cascades and in the irrigated valleys of the interior. Beef cattle are found throughout the region, but the greater concentrations are in the Upper and Central Snake and Oregon Closed Basins Subregions. More than 55% of the sheep are in Idaho, with the heaviest concentrations in the Upper Snake and Central Snake Subregions.

Large quantities of grain, grass seed, potatoes, fruits, hops, beet sugar, vegetables, nuts, peppermint, and berries are exported from the region. Beef, although an important product of many localities, must be imported along with pork. In general, dairy products meet areal demands, with some export of specialities.

Marcus Whitman was probably the first person to irrigate crops within the region beginning in 1836 near Walla Walla, Washington. The next several decades saw many irrigation systems developed; generally they served one or a few farms. The major concentration of early irrigation was in the Upper Snake Subregion where by 1950 a substantial percent of the 2.5 million acres currently irrigated were already under ditch (7-115). Extensive developments began in the late 19th century, permitting agriculture in low rainfall interior areas. This allowed greater intensification and diversification; fruit, vegetables, corn, and irrigated hay and pasture could be grown where extensive grazing had been the rule. These crops fostered fruit and vegetable processing industries, as well as dairying and cattle feeding. Dramatic increases in crop production have been wrought from a considerable portion of the region's lands.

By 1950, irrigation had become a key factor in the agricultural economy of the region. About 72 percent of the initial irrigation development had been made by individuals, cooperatives, and agencies other than the Federal Government. However, beginning in the early 1900's the Federal Government was called on for

Irrigation has transformed desert lands into productive cropland.

assistance, primarily for supplemental water, so that by 1966 a major portion of the irrigated area had received some Federal support.

In 1966, total irrigated areage in the region was about 7.3 million acres. Since 1944 the irrigated acreage has increased about 100,000 acres annually.

For many years, little attention was given the problem of suitable land use in settlement expansion on the vacant Public Domain. It was up to individual settlers to decide whether a given tract of land could be farmed and to what type of farming it was best adapted. No attempt was made to classify the land according to its best use in advance of settlement, and the public land laws governing settlement failed to take into account the fact that, for successful cultivation, the amount of land being operated as a unit must vary in accordance with the type of farming. As a result, serious maladjustments in the use of land occurred in the Pacific Northwest. Settlers cleared land and planted crops in the humid, cutover forest areas that could not provide them a decent living. Lands were planted to dry-farmed wheat where insufficient rainfall or severe erosion precluded successful crop production over any extended period of time. Many farms were too small to support a family if farmed within their capabilities. Not only was it impossible for many of the individual settlers to make a living, but the basic land resources of the region were threatened with destruction.

Legislation passed in 1935 under the Soil Conservation Act provided for the control and prevention of soil erosion, the preservation of natural resources, and the protection and conservation of soil and water. Improvement programs were initiated to facilitate land and water conservation and management on private property.

Meanwhile, progress was made in determining carrying capacity of the public range, and in adjusting the number of livestock to its capacity. By 1934, it was estimated that on over 12 million acres in Oregon, Washington, and Idaho, three-quarters of the top soil and some subsoil had already been lost, and more than 3 million acres had already been destroyed or severely damaged by wind erosion. The rangelands had been used in excess of their grazing capacity, and consequently had seriously deterioated. Improvement and proper management of the range required uniform administration of large blocks of land, and this was difficult where tracts were made up of small and scattered holdings. These were the conditions in the Pacific Northwest in 1934 when the Taylor Grazing Act was enacted. This Act authorized the Secretary of the Interior to establish grazing districts and adjust the livestock to the carrying capacity on the range. That

same year an Executive Order withdrew all Public Domain from further entry and provided that individual settlement would be allowed only if the lands were suitable for the proposed use.

Rangeland and areas suitable for livestock forage production account for 50 percent of the total regional area. This includes 58.8 million acres of range and 28.9 million acres of forest land that are grazed or have potential for forage production.

The estimated capacity of all suitable grazing land was 9.8 million animal-unit months in 1966, of which about 25.5 percent was within the forested range areas. Broad estimates indicate that 59 percent of the forage production came from the public rangelands and 41 percent from privately owned range, both forested and non-forested. On some of the region's rangeland there is strong competition between domestic livestock and big game.

Forest Industry

Throughout the history of development in the Columbia-North Pacific Region, timber has been important in shaping the economic and settlement patterns. Utilization of forest products began during the establishment of the fur trade and continued to grow with the settlement of the region.

Water has played an important role in the production and utilization of the timber resources. Early harvesting was almost entirely adjacent to water that could be used to transport logs and finished products. Harvest moved away from the water courses as the forests were cut, but mills remained on the streams and bays. Present industry (i.e., the production of pulp) is based upon the availability of large quantities of water.

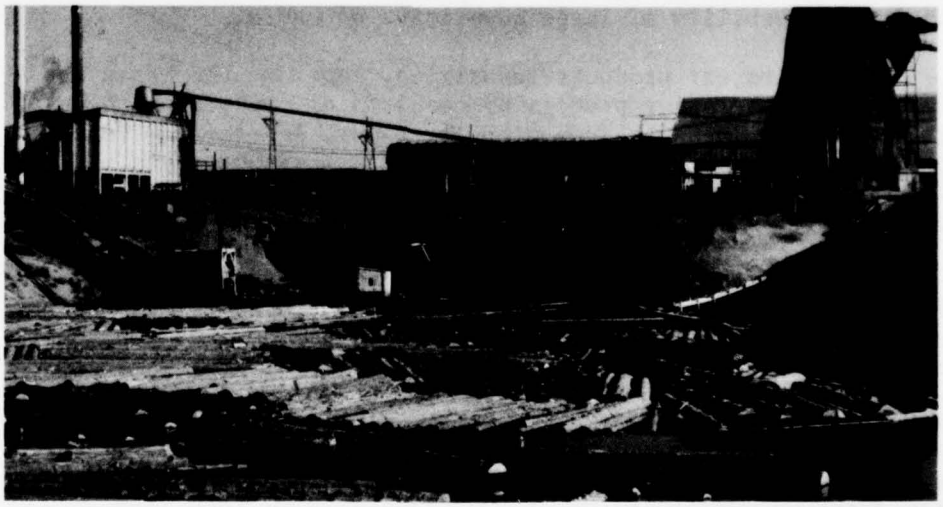
In the forest products industries, logs are the basic raw material, and the major processing consists of converting these logs to such products as lumber, pulp, paper, fiberboard, veneer, and plywood. A secondary industry converts these products of primary industry to a more highly fabricated product (such as doors, boxes, and furniture).

In 1827, the Hudson Bay Company constructed a mill six miles from Vancouver, Washington, which employed 20 to 30 men and produced 3,000 board feet of lumber per day or about 900,000 board feet per year. By 1849 over a million board feet of lumber had been shipped from the Columbia River to California, and by 1850 there were more than 30 sawmills in the region. Some of the early millsites included Cathlamet (1844), Oregon City (1844), Tumwater Falls (1846), and Whitman's Mill in the Blue Mountains near Walla Walla (1846). Principal interior mill centers in 1850-1882 were Grants Pass, Grande Ronde in the Blue Mountains, and Spokane.

The sawmilling capacities increased rapidly. In 1900, some of the larger companies already had bandsaws producing 150,000 board feet per shift. In 1915 there were at least two electric mills under construction--the Weyerhaeuser mill in Everett, Washington, and Booth Kelley in Eugene, Oregon, with daily sawing capacities of 350,000 and 150,000 board feet, respectively. Also in 1915, in the pine country at Bend, Oregon, the Brooks and Shevlin mills had established sawing capacities of 250,000 board feet per day.

To produce logs for sawmills, early logging used oxen, horses, peaveys, crosscut saws, axes, skidroads, and strong men. Steampowered yarding and loading equipment came into use about 1890. Railroad logging with steel spar skidders appeared about 1915; these 100-foot towers on rails introduced high-lead logging. In the pine country in the forepart of the century, high wheels with horses were used for skidding; the logs were suspended under the axles. It was in the pine country where the logging truck was introduced in 1914, and the trailer came into use in 1920. About that time, small tractors began to replace horses for yarding logs.

In 1965, the lumber industry produced nearly 15 billion board feet of lumber and allied products. Present-day principal lumber producing centers include Emmett, Lewiston, Coeur d'Alene, McCall, Council, and Cascade, Idaho; Missoula, Bonner, Libby, and Kalispell, Montana; Burns, Bend, Coos Bay, Cottage Grove, Eugene, Lebanon, Medford, North Bend, Portland, Prineville, Philomath, Roseburg, Springfield, and Sweet Home, Oregon;



The timber resource of the Region is an important factor in its economic growth. (Oregon State Highway Department)

Aberdeen, Everett, Longview, Seattle, Spokane, Tacoma, and Vancouver, Washington. Oregon is the Nation's leading lumber producing state.

The pulp and paper industry became established somewhat later in this region than in other parts of the United States. Early development was delayed by transportation problems and the distance from the principal centers of consumption. Then, too, just as in other parts of the country, it followed only after a large lumber industry had become established. By the late 1920's, the pulp and paper industry was growing rapidly.

A factor fostering the development of the pulp industry in the Pacific Northwest was the demand in the 1930's for sulphite pulp to supply the eastern paper and rayon industries. The sulphite process introduced a use for hemlock, spruce, and true firs, as these species were suitable for pulping by this process. Heretofore, those species were little used, as they were not preferred for lumber. The high pitch content of Douglas-fir and ponderosa pine made these two species unsuitable for pulping until the sulfate or kraft process was developed after 1945. Most of the newer mills are designed for the sulfate process and have been integrated with sawmills to utilize sawmill residue and, in some instances, residue from logging operations. About 70 percent of all pulpwood now used in the region is sawmill residue. Some pulp and paper mills operate almost entirely by using chips obtained from their own or independent sawmills.

Douglas-fir plywood was first made on an experimental basis in 1904 and in 1905 exhibited during the Lewis and Clark Exposition in Portland, Oregon. Initially it was intended only for doormakers as panels and for drawer bottoms. Until 1920, plywood operations were only a part of a door factory or plant making boxes and crates.

By 1927, the plywood industry was well established commercially with an output of 206 million square feet (3/8-inch material) for exterior and interior panels, building, and industrial uses. Significant progress was marked by replacement of blood glues with soybean glues in 1927; use of cold peeling process in 1930; development of a hot press in 1935; and the introduction of phenolic resin adhesives, and the subsequent production of exterior type and special grades of plywood. In 1965, production from 131 plywood plants amounted to 11 billion square feet (3/8-inch basis) of softwood plywood.

Since 1918, this region has been the Nation's leading lumber producer and during the period 1955-1962 has supplied 46 percent of the softwood lumber and 36 percent of the total lumber, over 35 percent of the softwood plywood, 17 percent of the woodpulp, 7 percent of the paper, 95 percent of the shingles, and 66

percent of the lath. In 1965, the region accounted for 41 percent of the Nation's lumber and 89 percent of its plywood production. Since 1946, over half of the Nation's total lumber exports have originated here. In 1962, the forest products industry employed 40 percent of all persons engaged in manufacturing in the Northwest. The employment dropped 9 percent from 1950 through 1962, mostly due to shifts in total production, increased efficiency in manpower, technical advances, and changes in kinds of products. In 1965, it increased 7 percent as the demand for wood products increased.

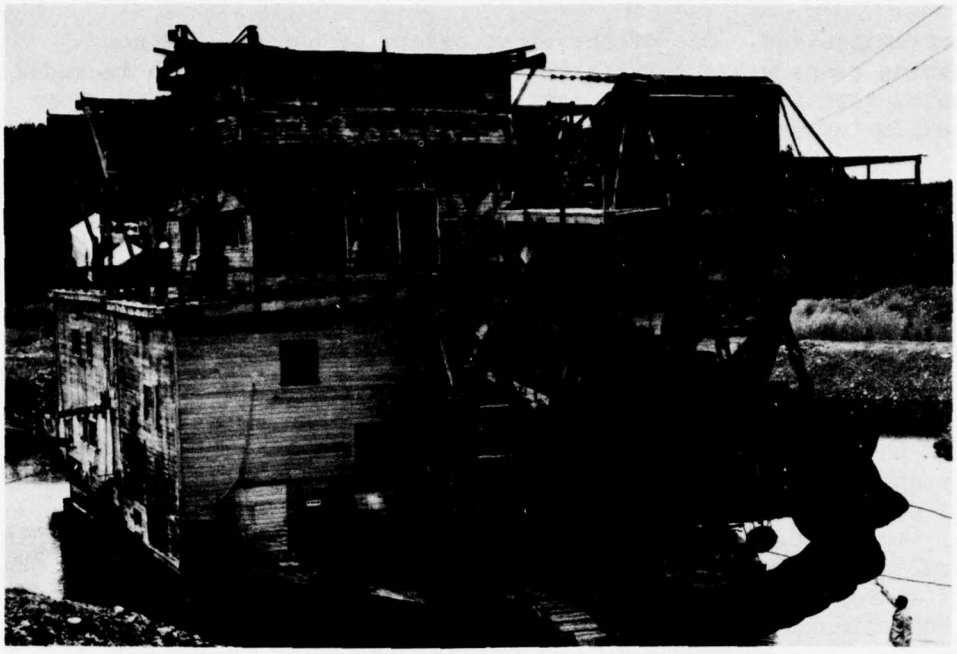
In both the woods and mills, technical and mechanical advances have improved the efficiency of labor and the quality of products. The present-day problems are related to the transition from old-growth timber to an economy based on newly grown tree crops. The problem involves securing more complete utilization of the timber grown and more intensive management of the total forest resource.

Mining

Mining was and is an important part of the economy. The great influx of people to the Pacific Coast, as a result of the discovery of gold in California in 1848, had a quickening effect on the economy of the Oregon Territory through the export of agricultural products and lumber to California. Discoveries of minerals were also made in the Columbia-North Pacific Region, and these discoveries were directly responsible for the establishment of many permanent settlements.

Except for some coal mined for local use in the Puget Sound area, placer gold was the first mineral to be exploited. It is not precisely known when gold was first discovered. However, the presence of gold in the Boise Basin of Idaho was known as early as 1844 by a trapper; but the discovery was not exploited until the late 1850's. In 1850, gold was found in the Klamath River just south of the region and, in 1852, gold was discovered on Jackson Creek in southwestern Oregon and on Gold Creek in Montana. These discoveries, however, attracted but little attention. By 1855, gold was being placer mined along the Columbia and some of its tributaries. The resultant influx of prospectors into northeastern Washington was deeply resented by the Indians and was one of the causes of the Indian wars that followed.

The first big gold rush followed the discovery of gold on Orofino Creek, in Idaho, in 1860. Other discoveries were made on the Salmon River, in the Boise Basin, Coeur d'Alene, Silver City, and elsewhere. By 1863, 25,000 miners were in southern Idaho. Idaho City alone had a population of 6,200 and was larger than Portland, Oregon. These placers were very rich, and it is estimated that over $20 million was produced from Orofino and



Gold dredges, once a common sight on many of the Region's gold bearing streams. (Oregon State Highway Department)

neighboring camps in the first four years following discovery. The rich gravel was soon exhausted, but mining of the lower grade gravels continued for many years. Discoveries in Idaho were followed by discoveries in 1860 on the John Day and Powder Rivers in Oregon and, in 1862, by an important discovery at Bannock, Montana. This discovery brought a rush of miners into Montana and resulted in finding rich placers at Helena, Marysville, Virginia City, and elsewhere. The Virginia City-Alder Gulch placers alone are said to have yielded $30 million in their first three years. Although this mining was east of the Continental Divide, it had an important influence on the settlement of adjacent areas.

By the 1880's, practically all of the presently known mining districts had been discovered and lode mining was well underway. The establishment of base-metal mining did much to hasten the establishment of roads, railways, and other means of communication.

Hand in hand with the establishment of the mineral industry was the harnessing and use of water. The early placer miners first conducted their operations directly in the gold-bearing stream bars. Later, bench deposits of placer gold were worked with hydraulic equipment powered by water often brought in by ditch for considerable distances. Numerous diversion dams and reservoirs were constructed and the first power plants were built by mining companies. The impact of the miner on water resources can hardly be

overemphasized. One of the first orders of business in new mining camps was the drafting of local mining laws which included water regulations. These laws applied to mining districts whose boundaries are still recognized today.

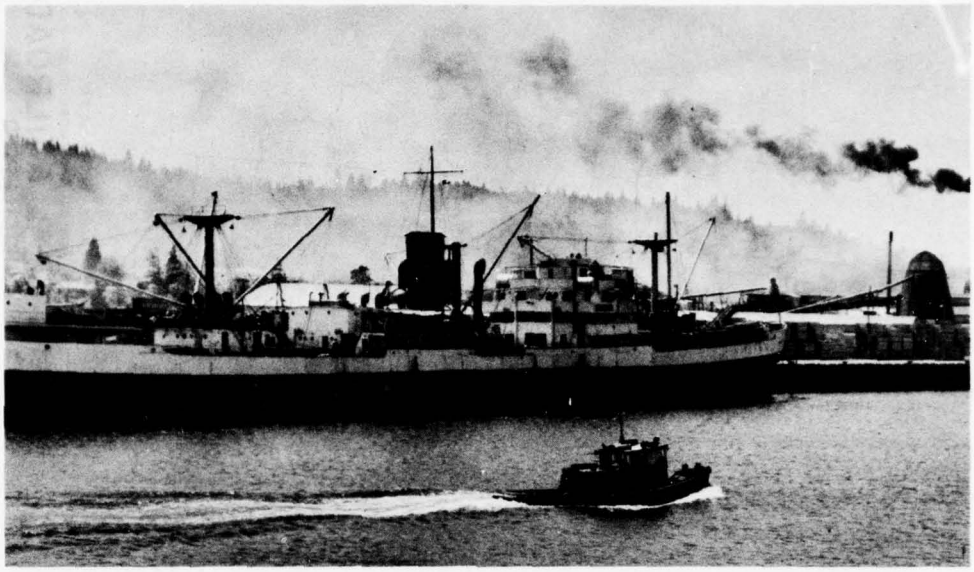
The early-day miner brought many things of lasting benefit. The discovery of gold in the streams introduced the essential elements of growth and development in the form of a vast outpouring of primary wealth readily translatable into the durable goods and services required to build a healthy economy and a strong political body.

The mining industry today is characterized in many areas by large, well-established operations which have been producing for many years and have sufficient reserves to last for many more. By and large, these mines are generally producers of metals such as gold, silver, copper, lead, zinc, antimony, and mercury. Equally as important, but of a much different type, are the industrial mineral operations which are found in many communities in each of the 12 subregions, such as the production of sand and gravel, crushed rock, limestone, pumice, expandable shale, brick and tile clay, refractory clay, and many others. Community development depends heavily on these construction materials. Water is needed for washing, sizing, and concentrating, making them heavy water users. Modern practice is towards increasing reuse of process water, but as high-grade deposits are exhausted and lower grade reserves must be used, the quantity of water required will remain high.

Approximately $10 billion in wealth has been extracted from the region's mines and quarries, which include three of the world's important mining districts. Butte, Montana, is one of the country's important sources of copper, with a total production of at least $3.8 billion in copper, silver, gold, manganese, zinc, and lead. Coeur d'Alene, Idaho, is the country's leading silver-producing area and one of the leading sources of lead and zinc, with a total production of over $2 billion. Metaline, Washington, has a total production exceeding $130 million in lead, zinc, silver, and some copper. Oregon has the only active nickel mine in the United States, and has been an important source of mercury, as well as several other metallic and nonmetallic minerals.

Transportation

During the earliest period, most imported and exported goods moved by ship. Goods, especially grain, moved by sea to the east coast, Europe, California, Hawaii, and the Orient. Small boats moved products down the Willamette and Columbia Rivers to the sea. Portland was the first of the cities on a river to develop communication and transport links with outside cities.



Access to water transportation is available via several harbors along the Coast. (Oregon State Highway Department)

By 1860, steamboat competition on the Columbia and tributaries had become severe enough to force a combination of small enterprises; the Oregon Steam Navigation Company emerged to monopolize river transport in the Northwest for twenty years. Unlike other western enterprises, shipping in the Northwest was locally owned.

The dependence on water transportation was underscored by the delays in completion of a transcontinental railroad link.

The first railroad route was surveyed in 1853. However, little construction progress was made until 1870, when the land grants were offered entrepreneurs who were willing to build. Several roads were started, then left uncompleted for various reasons. However, by the latter 1870's there were fairly good internal routes connecting the Willamette Valley and Puget Sound with their ports. These were constructed through the efforts of such famous railroad men as Ben Holladay and Jay Cooke. Attempts to connect these railroads to eastern terminals were in vain until Henry Villard became actively engaged in railroad building. He consolidated several routes and built several hundred miles of new track into the first transcontinental link. Finally, in 1883, the first train crossed the Continental Divide via the Northern Pacific tracks and ushered in a new era of transportation. Within five years, other routes were completed connecting with additional eastern points and California.

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

PRINCIPAL RAILROAD ROUTES THE REGION 1968

FIGURE 3

Railroad building continued and soon approximated the present routes (see figure 3). A network composed of the Union Pacific; Southern Pacific; Spokane, Portland and Seattle; Great Northern; Chicago, Milwaukee, St. Paul and Pacific; and Northern Pacific Railroads connect Puget Sound, the Willamette Valley, coastal points, the Deschutes area, Columbia Basin, Montana mining cities, and Snake Valley towns.

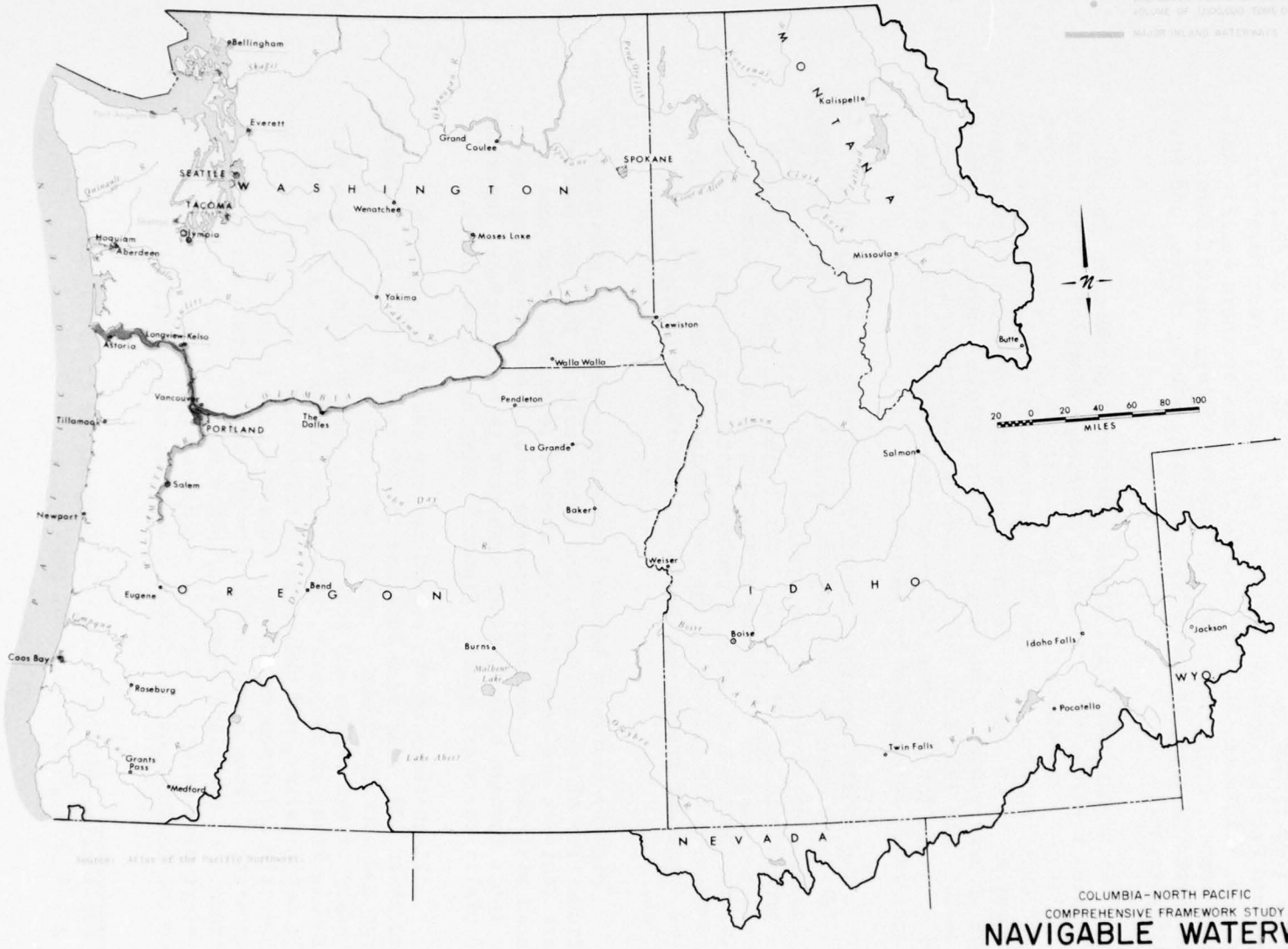
With increased agricultural and forest production, barges and ships carried ever increasing tonnages. Shipping was especially stimulated by the Alaskan gold rush. Harbors at Portland and Puget Sound were improved and some smaller communities specialized in exporting grain or lumber. Improved rail lines replaced water transport in some places, resulting in faster service. During the period from the late 1930's to the late 1960's, construction of the dams and locks on the Columbia and lower Snake Rivers provided an even longer reach for slack water navigation.

The tonnage passing through the region's ports has risen significantly over the past several decades. Between 1946 and 1956, an increase of 41 percent was realized; the following nine years, the growth rate was 22 percent. Total gross tonnage for 1965 was 79 million tons. 1/ Slack water transportation on the Columbia River to the tri-city area of central Washington became a reality in 1968 with the filling of the pool behind John Day Dam. Figure 4 shows important present-day ports and waterborne transportation routes.

Highway transport became increasingly important after the introduction of trucks, buses, and autos early in the 20th century. These vehicles are more flexible, cheaper to operate, and soon replaced railroads in marginal resource areas. As a percentage of the total tonnage hauled, truck transport is becoming more important, especially for short hauls. Figure 5 shows the major routes.

All portions of the region are now served by highways. Interstate 80N leads from Portland to the east through the Columbia Gorge and southern Idaho. Interstate 5 begins at the northern boundary of the region and runs south through Seattle, crosses the Columbia River at Vancouver, runs south through Portland and the Willamette Valley, and continues to California. Interstate 90 starts at Seattle and connects through Spokane to the Plains States. Interstate 15 runs north, south through eastern Idaho and western Montana. An excellent network of other federal, state, and county highways also exists. Seasonal and all-weather roads, extending into the mountainous and desert areas, are used principally for

1/ Duplication of data results because of the transshipment of goods through more than one port.

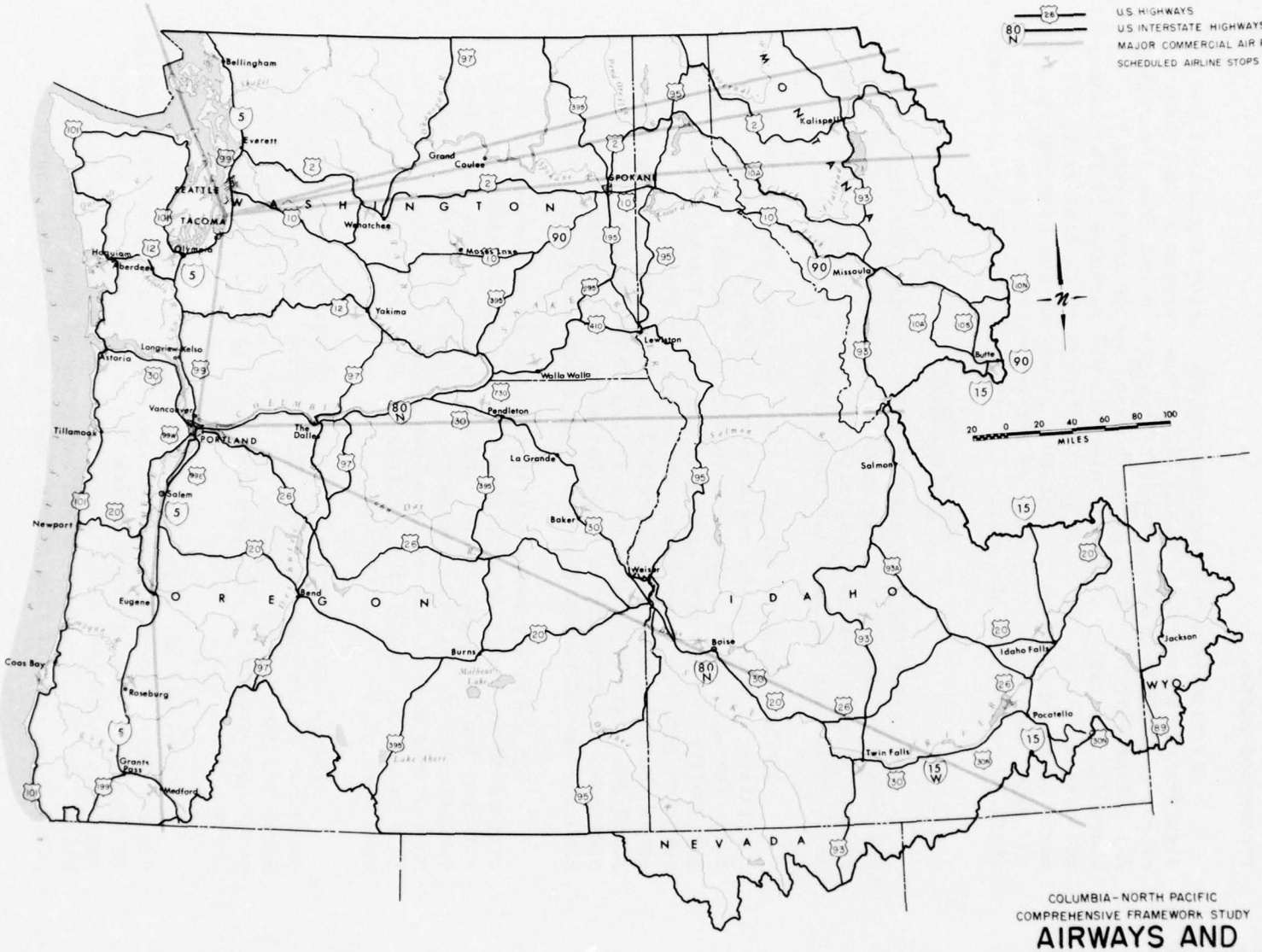


COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

NAVIGABLE WATERWAYS AND PORTS THE REGION

1968

FIGURE 4



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AIRWAYS AND FEDERAL HIGHWAYS THE REGION

1968

FIGURE 5

logging, fire control, and access to fishing, hunting, and recreation areas.

Air transport has expanded rapidly. From a point of insignificance prior to World War II, it now carries a good share of the passengers and many types of freight to and from the region. All cities with more than a few thousand people are served by scheduled air lines. The two international airports at Portland and Seattle-Tacoma are major points through which traffic to all parts of the world flows. Continued expansion has been and is the major feature of this mode of transportation. Figure 5 shows the major commercial air routes and cities with scheduled service.

Electric Power

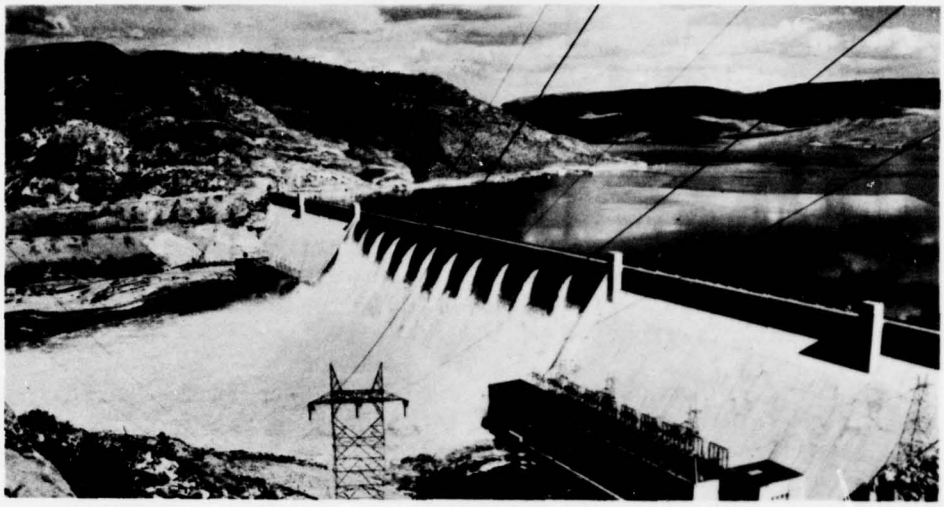
Ever since the beginning of the electric power industry in the region in about 1882, water has been the chief means of generation. This is in great contrast to the remainder of the Nation which relies for the most part upon thermal generation.

The abundance of suitable sites for dams and generation facilities on most of the region's major streams provides cheap power for most of the urban and industrial centers. Because of availability of low cost hydroelectric power, the per capita consumption rate has grown to be the highest in the Nation. Per capita power consumption increased tenfold in thirty years, from about 1,200 kwh annually in 1937 to over 12,000 kwh annually in 1967. In addition, the inexpensive power has attracted industries such as aluminum manufacturers that are heavy users of electric power.

The privately owned utilities which serve the region originated as small, locally owned enterprises providing utility services including gas, water, and electricity. Some were even subsidiaries of railroad companies. Most of these small companies have either merged with or have been absorbed by other companies. This trend has continued until today a few large companies distribute most of the private power.

Tacoma was the first large city to establish municipal ownership of its power supply. Other cities and special districts, large and small, have followed and today there are numerous public ownerships supplying residents and industry with low cost electric power.

On August 20, 1937, President Roosevelt signed the Bonneville Project Act. Two Federal generating plants were under construction at that time, one at Grand Coulee Dam and the other at Bonneville Dam. The Bonneville Power Administration was given the responsibility for the distribution and marketing of power from these projects as well as from future Federal dams. In the course of



Grand Coulee Dam, a major project on the Columbia River, supplies water for irrigation as well as producing electric power and providing recreation and flood control benefits. (USBR)

this development, interconnections were made with the municipalities and private facilities, thus setting the stage for eventual coordinated operation.

By the end of World War II, six new Federal plants had been authorized on the Columbia River. In 1947, construction began on McNary Dam by the Corps of Engineers. The Bureau of Reclamation began work on Hungry Horse Dam on the Flathead River in 1948, and the Corps started work on Detroit and Lookout Point projects in the Willamette Basin in 1949. New authorizations and construction proceeded rapidly thereafter so that, by 1954, when Cougar and Green Peter Dams received Congressional approval, all operating projects in the present U. S. Columbia River Power System had been authorized. These projects were the last to be authorized for many years by Congress for the Columbia River drainage.

The local public agencies stepped into the gap created by the lack of newly scheduled Federal generation by requesting licenses for large mid-Columbia River projects. At the same time, financing arrangements were arrived at whereby the output of such projects was disposed of to other utilities, as their capability far exceeded the loads of the licensees. Under such arrangements, construction was started on Priest Rapids in 1956, Rocky Reach in 1957, Wanapum in 1959, and Wells in 1963.

Private projects have continued to be constructed and their electric power output has become a significant percentage of the total power production capacity. Examples are the projects constructed on the Clark Fork, Pend Oreille, Spokane, Snake, Deschutes, Clackamas, Lewis, Skagit, Cowlitz, and McKenzie Rivers.

In the past twenty years other actions of significance to the growth in the regional power system were taking place. These culminated in 1964 in three accomplishments which greatly expanded the scope of power operations and will vastly affect the flow regime of the Columbia River. The three were (1) ratification of the Columbia River Treaty by Canada, (2) authorization of the Pacific Northwest-Southwest high voltage transmission interconnections, and (3) the Pacific Northwest Coordination Agreement. These actions should not be viewed in isolation, as they are, in fact, closely interdependent. The time schedule for each is geared to the accomplishments expected of the other two.

Presently, Bonneville Power Administration is the marketing agent for power produced at twenty-two Federal hydroelectric plants with an installed generating capacity of 6.8 million kilowatts (kw). Eight new hydrogenerating facilities are planned for the future with a capacity of more than 7 million kw. Private power production is currently 7.3 million kw. This includes thermal generating capacity of approximately 1.25 million kw, which is expected to grow rapidly.

Fisheries

Similar to the other natural resources of the Columbia-North Pacific Region, fish have played an important role in its development.

The commercial fishing industry of the Pacific Northwest began with the harvest of salmon from the Columbia River. This activity was in large measure a continuation of the centuries-old practice of the Indians utilizing the abundant salmon runs. The commercial fisheries which started in the 1850's and expanded rapidly were based on the export of salt cured salmon.

The first salmon cannery was constructed in 1866, followed during the next twenty years by many more at all major ports in Oregon and Washington. From about 1875 to 1930, the commercial salmon harvest remained relatively stable, but has declined steadily since that time. Data on total salmon and steelhead harvested from the Columbia River are illustrative of what has occurred throughout the region during the past ninety years:

Years	Average Landings/Year
1866-1870	4.1 million pounds
1881-1885	40 million pounds
1916-1920	41 million pounds
1961-1963	6.1 million pounds
1964-1966	10.5 million pounds

The recent increase for the Columbia River is largely the result of improved hatchery techniques which have increased the runs.

In addition to canned and cured salmon, fresh and frozen fish became important with the growth of transportation facilities. This movement of fish continues today with Pacific salmon being available throughout the United States.

The major gear for taking salmon in fresh water has been the gill net, while trolling is most important in the ocean. Other devices such as fish wheels, traps, and seines were used but are now illegal.

Other freshwater commercial fisheries include: carp, crayfish, sturgeon, American shad, eulachon, and Pacific lamprey. Harvest of these has fluctuated considerably during the past twenty years with a downward trend evident for all species except shad. However, fluctuation of landings is associated more with market demand than with abundance.

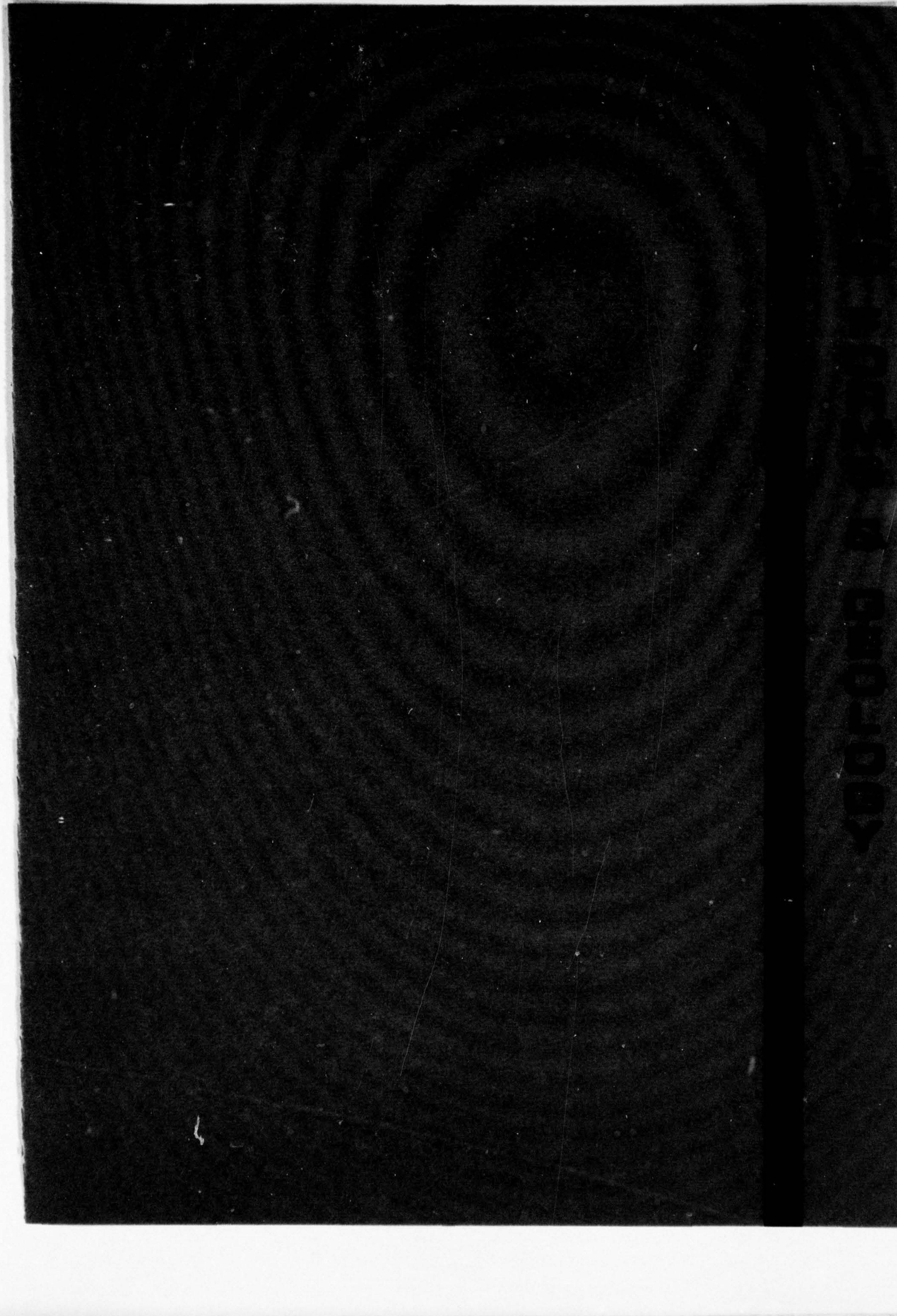
Marine fishes are not directly dependent upon freshwater for existence; however, they have contributed significantly to the region's development and economy. As human and animal food resources, marine species greatly exceed, both in varieties of fish and poundage, the anadromous species, however, value per unit harvested is generally much lower.

Ocean fishing became significant during the early 1900's. Tuna, sardine, anchovy, and herring are the principal open ocean species and the principal bottom fish are halibut and sablefish. The halibut fishery is one of the oldest on the Pacific Coast as well as one of the most prized. It is managed through international treaties dating back to 1923. Other commercial fishes include cod, hake, soles, and rockfishes. Various sharks and mammals are also taken.

Shellfish harvested commercially in the Pacific Northwest waters include shrimp, Dungeness crab, clams, and oysters. With the exception of shrimp, commercial production of each of these species has declined steadily over the past twenty years, although recreational harvest of crabs and clams has increased considerably.

While most of the fishing by early immigrants was to obtain food, there was undoubtedly some recreational value. As our civilization has developed and we have prospered, there has been a greater tendancy to pursue sport fishing for its recreational value. In Oregon alone in 1965, 4,734,000 angler-days of effort were spent in catching 981,000 anadromous fish (primarily salmon and steelhead), 7,597,000 trout, 1,527,000 warm-water fishes such as bass and catfish, and 482,000 bay and ocean fishes such as flounder and

perch. And there is a strong indication that sport fishing will become more and more important because of our soaring population with its increased leisure time.



LAND FORMS & GEOLOGY [1/]

Although the Region has a variety of rock types, its outstanding characteristic is the predominance of volcanic rocks. More than half of the Region is underlain by lava flows, pyroclastics or sedimentary rocks composed of volcanic materials. Other rock types include granitic, metamorphic, and consolidated sedimentary rocks. These are largely confined to the southern Coast Range, the northern Cascade Range, and ranges of the Rocky Mountain system. The rocks and their relation to landforms, soils, ground water supply, and streamflow are described in the following sections.

The Region is composed of several distinct physiographic provinces: (1) the Coast Range, including the Olympic Mountains running north and south along the western edge of Oregon and Washington; (2) the Puget Sound-Willamette Valley Trough paralleling the Coast Range; (3) the Cascade Range forming the east side of the Trough; (4) the Columbia Plateau in east-central Washington and north-central Oregon; (5) the Blue Mountains of northeastern Oregon and southeastern Washington; (6) Oregon Closed Basin; (7) the Snake River Plateau of southern Idaho, northern Nevada, and southeastern Oregon; and (8) the Northern Rocky Mountains comprised of the Bitterroot, Cabinet, Selkirk, Salmon River, Okanogan Highlands, and associated mountain ranges on northern, central, and eastern Idaho, western Montana, western Wyoming, and northeastern Washington (see figure 6).

COAST RANGE

The Klamath Mountains, at the southern end of the Coast Range, consist of a complex of pre-Tertiary sedimentary and volcanic rocks, large areas of which have been metamorphosed to schist, gneiss, and greenstone. Intrusive igneous rocks, ranging from granite to periodotite and serpentinite, crop out in several large areas. The entire complex has been folded, faulted, uplifted, and greatly eroded to form a rugged mountain group with canyons and a few broad, alluvium-floored valleys.

The Coast Range proper extends from about the Rogue River northward to the Chehalis River, and consists of consolidated

1/ The major divisions used in this section are based on: Fenneman, Nevin M., Physiography of the Western United States, McGraw-Hill, 1931

rocks of Tertiary age. Marine sedimentary strata, including sandstone, siltstone, and shale, with small amounts of limestone, predominate in the southern part of the range in Oregon; basaltic and andesitic flows and interbedded pyroclastics and tuffaceous sediments predominate in the northern part of the range in Oregon and southern Washington. The rocks have been folded and faulted, but not metamorphosed. Uplift and dissection have produced a rugged terrain, generally with sharp canyons and narrow alluvium-floored valleys.

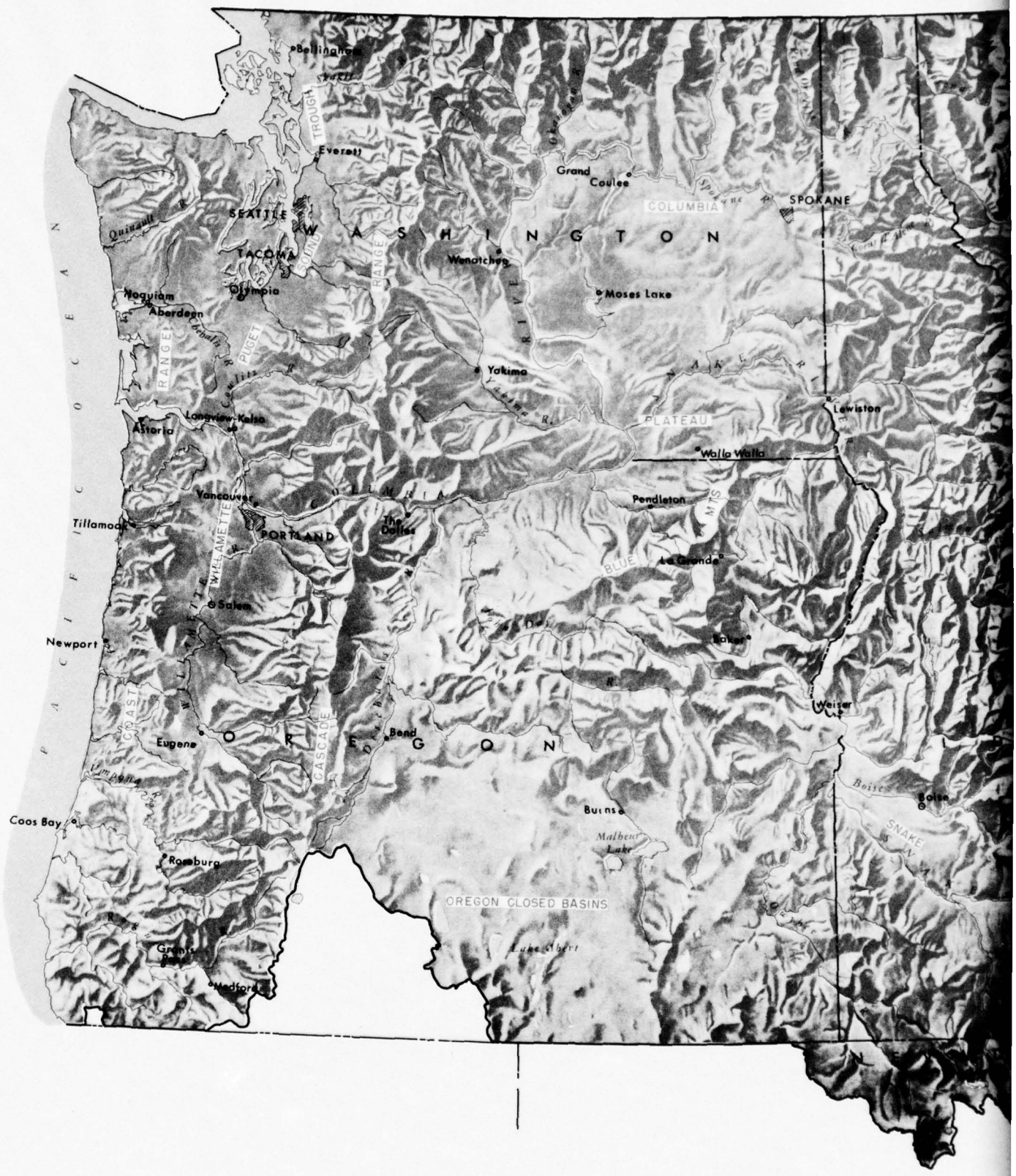
The Olympic Mountains consist of a broad central core of early Tertiary and pre-Tertiary argillite and graywacke, partly surrounded by rings of successively younger, early to middle Tertiary volcanic and sedimentary rocks. Folding and uplift have resulted in a broad, deeply dissected dome-shaped mountain range with radial drainage.

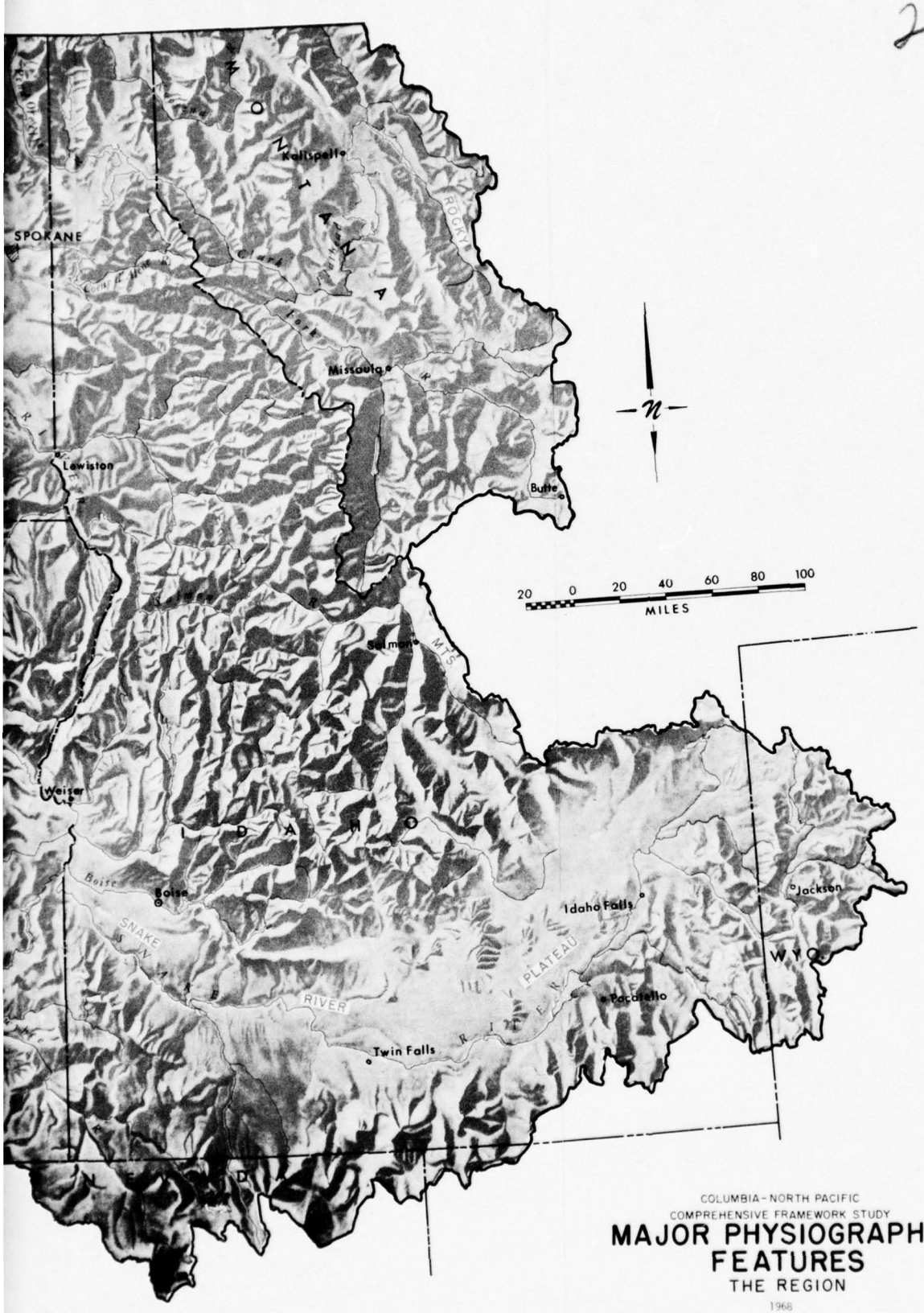
Narrow coastal plains underlain by unconsolidated to semi-consolidated sand, silt, and gravel at places extend along the Oregon and Washington coasts. Marine silt and clay, and fluvial sand and gravel, all of early Pleistocene age, form a broad terrace around the southwest flank of the Olympic Mountains.

Practically all the soils in the Coast Range division are formed in colluvium and residuum developed by weathering of the underlying bedrock under humid climatic conditions. Differences in the soils are primarily related to differences in the environment and underlying rocks. Soils on the sedimentary strata commonly are grayish brown to reddish brown, sandy loams to clays. Soils on the volcanic rocks are red to brown lateritic loams to clay loams.

Most of the rocks are older Tertiary, or pre-Tertiary in age, and have been compacted, cemented, and altered so that little of the original porosity remains. Most of the ground water occurs in joints and other rock fractures, and in the weathered zone. Drilled wells obtain water from the fractured rock and generally yield small, occasionally moderate, supplies. Dug wells yield small supplies from the weathered zone. Wells and springs provide adequate yields for domestic, and small industrial and municipal use. Alluvial deposits in some valleys and dune and beach sands along the coast yield greater quantities of water.

Because the section is mountainous and maturely dissected, tributary streams are short and have steep gradients. Direct surface runoff is rapid. Considerable ground water is stored in the subsoil and upper part of the bedrock, but the storage is shallow, hydraulic gradients are steep, and ground-water storage depletes rapidly during periods of no recharge. For these reasons,


Bellingham
Everett
SEATTLE
TACOMA
Olympia
Aberdeen
Hoquiam
Quinault
Grand Coulee
SPOKANE
COLUMBIA
WASHINGTON
Wenatchee
Moses Lake
Yakima
Lewiston
Walla Walla
PLATEAU
Pendleton
Longview-Kelso
Astoria
Vancouver
PORTLAND
The Dalles
Tillamook
La Grande
Salem
Newport
Baker
Weiser
Eugene
Bend
OREGON
Coos Bay
Burns
Boise
Malheur Lake
Roseburg
OREGON CLOSED BASINS
Lake Abert
Grants Pass
Medford
PACIFIC OCEAN
COAST RANGE
WILLAMETTE
PUGET
CASCADE RANGE
BLUE MTS.
SNAKE R.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MAJOR PHYSIOGRAPHIC FEATURES
THE REGION

1968

FIGURE 6

the base flow of the streams becomes small during prolonged drought.

There are few peaks in the Coast Range proper which exceed an elevation of 3,000 feet. The mass of the Olympic Mountains at the extreme north rises sharply, and peaks reach nearly 8,000 feet. The Klamath Mountains rise abruptly from sea level to elevations of more than 5,000 feet. Most of the drainage from these coastal mountains is by small rivers running westward to the Pacific Ocean. There are, however, several larger valleys and estuaries providing gaps in the mountains. Where the Coast Range meets the Klamaths and forms an east-west barrier, the streams flow westerly from the Cascades to the Pacific Ocean.

WILLAMETTE-PUGET SOUND TROUGH

The Willamette-Puget Sound Trough lies for the most part below 1,000 feet elevation and between the Cascade Range to the east and the Coast Range and Olympic Mountains to the west. It is between 30 and 50 miles wide, and about 350 miles long. During the downwarping, subflexures developed so that the trough is interrupted at several places by hills extending along or part way across the trough. Alluvial and lacustrine deposits of late Tertiary age, and alluvial, glaciofluvial, and glacial deposits of Quarternary age underlie the floor of the trough. North of Centralia, most of the surface material is of glacial origin, deposited by an ice sheet which extended into the area from Canada.

A view showing the general characteristics of the Willamette-Puget Sound Trough - The alluvial and volcanic hills. (Oregon State Highway Department)

The hills rising above the alluvial floor consist of sedimentary and volcanic rocks identical with those that crop out in parts of the flanking mountain ranges and that underlie the alluvial deposits in the trough.

The present streams have cut down into the basin fill, and a thin veneer of recent alluvium has been deposited along the flood plains. Residual soils have developed on the sedimentary and volcanic rocks. Soils on the sedimentary rocks are commonly gray to brown, sandy loam to clay loam, and those on the volcanic rocks are reddish deep clay loam to heavy clays. Soils on the bench lands north of Centralia have developed on the glacial deposits, and include stony brown to reddish loam and clay loam on the till, and soils ranging from fine sandy loam to coarse gravelly loam, depending on the character of the underlying glacial outwash. In the valleys, the soils are recent alluvial sediments. In the Cowlitz and Willamette Valleys, soils include recent alluvium and gray to brown, sandy to clayey loams developed on older alluvial deposits.

Many wells drilled in coarse sand and gravel in the alluvial and glacial deposits have moderately large to very large yields. Because of medium to heavy precipitation in the section and bordering mountains, recharge is high; generally, much potential recharge is rejected as surface runoff. Large supplies of ground water are available at many places.

Most of the larger streams originate in the flanking mountain ranges; their flow is augmented by ground-water effluent from the alluvial deposits in the basins. The Willamette River in Oregon drains the area south of the Columbia River. In Washington, the Lewis and Cowlitz Rivers tributary to the Columbia, the Chehalis River draining into the Pacific Ocean, and the Skagit and other smaller rivers emptying into Puget Sound drain the northern part of the Trough.

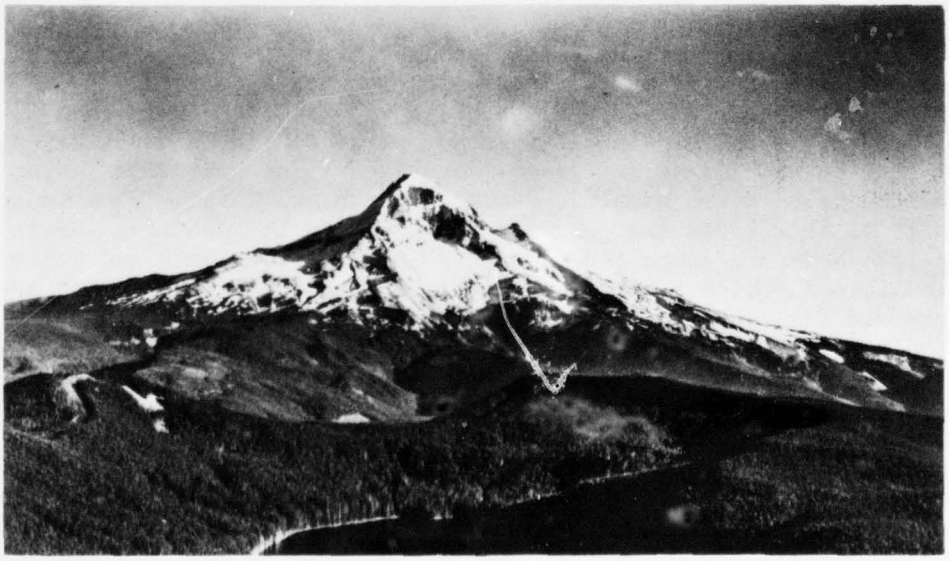
CASCADE RANGE

North of a line marked approximately by the courses of the Cedar and Yakima Rivers, the Cascade Range consists of a very rugged group of mountains carved from folded, faulted, and uplifted older (pre-Tertiary) igneous and metamorphic rocks such as granite, gneiss, schist, and greenstone. The two highest peaks, Mount Baker and Glacier Peak, however, were formed as volcanic cones built above the general level of the other mountains. South of Cedar and Yakima Rivers, the Cascade Range is dominantly constructional; that is, formed by outpouring of volcanic flows and pyroclastics in two periods; during the early and middle Tertiary, and in the late Tertiary and Quarternary

Periods. The older volcanic terrain has been considerably modified by erosion, but the younger volcanic rocks that form the High Cascade Range have retained almost intact their original form.

Soils in the northern Cascade Range are residual and range from light, erodible sandy loams to heavy clay loams. Soils on the older Tertiary volcanic rocks generally have a deep profile, and range from porous "shot" soils to heavy loams with clay subsoils. Younger volcanic rocks have a shallower soil, and some of the youngest materials have little soil development.

The igneous and metamorphic rocks generally have low porposity and permeability; however, a deeply weathered zone of soil and subsoil, which is moderately porous, stores a considerable amount of water that is discharged to streams during periods of low flow. Because this storage is shallow and gradients are steep in the rugged mountains, the ground-water reservoirs are drained rapidly and the base flow of streams becomes very low during periods of prolonged drought. The volcanic rocks range widely in their porosity and permeability. The older rocks in the Cascade Range generally have a moderate to moderately low porosity and permeability, but store a considerable volume of water in the upper part of the saturated zone. Ground-water storage depletes rather rapidly, and streams draining these aquifers have low base flows after prolonged drought. The younger volcanic rocks are porous and highly permeable, at places accepting more than 100 inches of precipitation without any



Mount Hood is typical of the volcanic peaks of the Cascade Range. (Forest Service)

surface runoff. Some streams draining areas underlain by such rocks receive 75 to 95 percent of their average discharge as ground-water effluent. These streams, as a rule, have relatively strong flows during dry seasons of the year.

The main crest of the Cascade Range lies at about 5,000 foot elevation, while several of the volcanic peaks of the range rise above 10,000 feet. Mount Rainier reaches over 14,000 feet; Mount Adams above 12,000 feet; and Mount Baker, Mount Hood, Mount Jefferson, and the Three Sisters above 10,000 feet. Except for a narrow gorge where the Columbia River has cut a route through to the ocean, this long mountain range sharply separates the coastal from the interior portions of the Region and has a strong influence on the climate of both parts.

COLUMBIA PLATEAU

Straddling the Washington-Oregon line, the Columbia Plateau is the central province east of the Cascades. From elevations of nearly 4,000 feet around the edges, the plateau slopes gently down to about 350 feet along the gorges of the Columbia and the lower Snake Rivers. At a distance, the plateau appears flat to gently rolling, but it is dissected by present-day streams and in the northern part by deep, vertical-walled coulees which were formed as temporary flood water channels during the time the course of the Columbia River was blocked by an ice sheet. Many small rivers drain the area which extends south from the upper curve of the Columbia to the Blue Mountains, west to the foothills of the Cascades, and east above the Snake just east of the Washington-Idaho line.

Throughout most of the Columbia Plateau the volcanic rocks are overlain by varying thicknesses of surface materials. Almost everywhere upland surfaces are mantled with a few to more than 100 feet of loess or windblown sand. North of the Columbia River, glacial outwash, sand and gravel, and lacustrine silt fill basins and channels in the basalt. Soils on the outwash range from sandy loams to silt loams and generally gravally in the profile. Soils on lake beds are compacted stratified silts. The loess and other windblown deposits range from sand to silt loams. These soils are deep and fertile, and are easily eroded.

The Columbia River Group, the glacial outwash, and the younger alluvium along present streams yield large quantities of water at many places. The alluvium, glacial outwash, and windblown deposits have a high porosity and store large volumes of water where saturated. However, in many places those deposits are above the water table, which is in the underlying basalt having low average porosity. Much of the area is semi-arid to

arid. Annual recharge probably does not exceed 3 inches, and in some places may be equivalent to less than 1 inch of water over the area.

In the western and southern parts of the Columbia Plateau, most of the discharge of streams is generated in the Cascade Range and the Blue and Ochoco Mountains. A considerable part of the eastern Columbia Plateau has little or no external drainage.

BLUE MOUNTAINS

To the southeast of the Columbia Plateau lie the Blue Mountains, extending from extreme southeastern Washington to central Oregon. Peaks in the Blue Mountains and associated ranges rise from 7,000 to 9,000 feet; but, in the separate outlying Wallowa Range on the east, they rise to more than 10,000 feet. This area is drained by the John Day and Crooked Rivers flowing west and north, by the Umatilla and Walla Walla Rivers flowing west to the Columbia, and by the Grande Ronde, Malheur, and other smaller tributary streams of the Snake River.

The Blue and Wallowa Mountains consist of a core of older crystalline, volcanic, and consolidated sedimentary rocks that stood as islands while the flood of lava and pyroclastic rocks formed the Columbia Plateau around them. Subsequently, the core and surrounding lavas were raised in domal uplifts and carved into a complex group of mountains. Some peaks, such as Aldrich Mountain, Elkhorn Ridge, and Eagle Cap, are of the older rocks; others, such as Black Butte, Strawberry, and Baldy Mountains, are capped by lava.

Soils on the older rocks are residual-colluvial. Light, loose, erodible sandy loam soil has developed from granitic rocks, and clay loams and clays on the older sedimentary and metamorphic rocks. Residual soil on the basalt is characteristically red-brown clay loam. Windblown silt mantles some of the gentler slopes at lower elevations.

The older rocks generally have low porosity and permeability; ground water moves through, and is stored chiefly in the moderately thick weathered zone of soil and subsoil. Interflow zones in the basalt have moderate porosity and permeability. Precipitation usually ranges from about 20 to 40 inches, and recharge is moderate. Most of the streams receive effluent seepage from the aquifers throughout the year, but storage in the older rocks is quickly depleted and base flows decline greatly during times of prolonged drought. Streams draining the basalt have a higher component of ground-water effluent and a slower recession.

OREGON CLOSED BASINS

Southernmost of the central provinces, the Oregon Closed Basins extend east across south central Oregon from the Cascade Range almost to the Oregon-Idaho line. The general base elevation is 4,000 feet, and peaks reach from 6,000 to 9,000 feet. The Basins comprise a high lava plateau with numerous basins and ranges formed by block faulting. A great thickness of relatively young (middle Tertiary to Quaternary) volcanic rocks and interbedded sediments underlies most of the area. The exceptions are some parts of the Pueblo, Steens, and Aldrich Mountains where older Tertiary and pre-Tertiary rocks crop out. The volcanic rocks in the western part are the youngest (pliocene to Pleistocene); fresh, unaltered lavas and pyroclastics related to the Cascade eruptions crop out over extensive areas. To the east, basalt, pyroclastic rock, and tuffaceous sedimentary rocks (Miocene and Pliocene) predominate. The fault-block basins contain lake- and stream-deposited sediments ranging from a few to several hundred feet thick.

The upland soils generally are light-textured silt to sandy-silt, alluvial or wind-deposited in origin. The soils in the basins range from fine windblown sand to heavy clay, clayey silt, or peat.

Most of the rocks are moderately to highly porous and permeable. Recharge to the aquifers occurs chiefly in the bordering mountains to the north and west, and on the fault-block ranges in the interior, where precipitation is greatest. Many streams in the mountains are perennial; in the dry season, their discharge is maintained by effluent seepage from aquifers. As the streams leave the mountains, they lose a large part of their flow to aquifers around the periphery of the basins. The remainder of the surface water is lost by evaporation and evapotranspiration along their lower courses, and evaporation from lakes and playas in the centers of the basins. Ground water is discharged into the lakes or is lost by evapotranspiration from the water table where it is near the surface in the lower parts of the basins. The water table is many hundred feet below the land surface under the broad upland areas although, locally, there are shallow perched water tables.

NORTHERN ROCKY MOUNTAINS

The northern Rocky Mountains consist of several mountain ranges formed by erosion of a broad uplifted area of consolidated sedimentary rocks, granitic intrusive rocks, and metamorphic rocks

The Sawtooth Mountains, one of the numerous ranges of the Northern Rocky Mountain Province. (Idaho Department of Commerce & Development)

including quartzite, argillite, limestone, and dolomite. All of these rocks, except for a few areas of Tertiary intrusive and volcanic rocks, are pre-Tertiary in age. The mountain ranges are separated by broad valleys and basins in which Tertiary volcanic and sedimentary rocks crop out in benches and high terraces, and underlie the valley and basin floors beneath surficial deposits of glacial drift, outwash, and alluvium.

The mountains in northern Montana and the eastern part of the Idaho panhandle are composed mostly of metamorphosed sedimentary rocks of the Belt Series. Mountains in the western part of the Idaho panhandle, northeastern Washington, and central Idaho consist chiefly of granitic intrusive rocks, with smaller areas of volcanic and sedimentary rocks. Mountain ranges in Montana south of Missoula, in southeastern Idaho, and in western Wyoming consist chiefly of sedimentary rocks of Paleozoic and Mesozoic age.

Soils developed on the metamorphic rocks are medium textured, quite permeable, and moderately fertile. Soils formed on the granitic rocks generally are coarse textured and of low fertility. Although highly permeable, their moisture-holding capacity is low. Wind deposited fine-textured soils of good fertility mantle some plateau segments and benches that are underlain by Tertiary basalt or sedimentary rocks. Soils developed on the glacial deposits and alluvium range from coarse sterile

sands to deep fertile loams.

Most of the consolidated rocks have low porosity and permeability, and store and yield only small quantities of water. However, a fairly thick zone of soil and subsoil has developed by weathering of the parent rock, and this zone is moderately porous. The water table usually is in this zone, and the aquifer stores and yields a large amount of water that maintains the base flow of streams during fair weather and at times in the winter when the precipitation is held as snow. Peak stream flows generally occur in the spring from precipitation and snowmelt. Minimum flows generally occur in the fall or early winter when ground water discharge is least. The alluvial and outwash deposits in the valleys are porous and permeable. They store and yield large volumes of ground water. Recharge to these deposits is chiefly from influent seepage from streams entering the valleys, and seepage from irrigation. The trunk streams receive large quantities of effluent seepage in their lower courses within the valleys.

Central, northern, and eastern Idaho, western Montana, and western Wyoming are covered with numerous ranges which make up this province. About half of these ranges, principally in the northern and eastern parts, have a north-south orientation. Between them are long, narrow valleys in which the major streams flow. The rest of the mountain masses are in blocks, rather than linear ranges, and are dissected by steep-walled valleys running in various directions. Elevations rise from 2,000 feet in the lowest valleys up to over 12,000 feet on some of the peaks. This group of closely placed mountains makes up the largest physiographic province. The southern part is drained by the Snake River and its principal tributaries, the Salmon and Clearwater Rivers, while the northern part drains to the Columbia in Canada through the Kootenai and Pend Oreille Rivers. Between these two systems, the Spokane River drains a considerable area of northern Idaho westward to the Columbia.

SNAKE RIVER PLATEAU

The Snake River Plateau is, for the most part, a very extensive volcanic plateau and extends from southeastern Oregon across southern Idaho into western Wyoming and includes parts of northern Nevada and Utah. In this report, the Snake River Plateau, actually a subprovince of the Columbia Plateau, includes the mountain ranges of southern Idaho and adjacent Nevada and Utah. Two sections are commonly recognized--the upper is generally referred to as the Snake River Plateau proper, and the lower is referred to as the Payette section. Elevations range from 3,000 feet along the Snake River to more than 10,000 feet in the peaks of the basin fringes. The eastern and northern edges of the

plateau lie at the foot of the Rocky Mountains. All drainage is to the Snake River.

Snake River Plain Subsection

The eastern part of the Snake River Plateau is dominated by the Snake River Plain, a young lava plateau. The gently sloping plain was built by basaltic lava and pyroclastic rock of late Tertiary (middle Pliocene) to Recent age, with large areas untouched by erosion. The chief erosional features are the canyons of the Snake River, which extend along the southeastern and southern margins of the plain, and Salmon Falls Creek. Along the southern flank of the subsection, south of the Snake River, are several fault-block mountain ranges composed of older rocks, that are separated by alluvium-floored basins. Basalt of the Snake River Plain sequence extends into the mouths of these basins. At the eastern end and the southwestern corner of the subsection, plateaus slightly higher than the Snake River Plain are underlain by slightly older (early to middle Pliocene) basaltic and silincic volcanic rocks. Alluvial sand and gravel, and lake-deposited fine sand and silt, overlie the basalt in extensive areas along the Snake River Valley.

The basalt surface of the Snake River Plain is virtually unweathered and little residual soil has developed. Over wide areas fresh bare basalt, scoria, cinders, and other volcanic materials are exposed. In other areas, windblown sand and silt have accumulated to thicknesses ranging from a few inches to many feet. The silt forms permeable, very fertile soil. Most of the soil on the plateaus south of the Snake River also is of wind-blown origin. Soil on the alluvial and lake deposits ranges from coarse, gravelly loam to heavy clay.

Except for moderate precipitation on the fault-block ranges, the subsection is arid to semi-arid. Most of the water entering is surface runoff and ground-water underflow from basins flanking the plain to the north or to the east and southeast. Generally, the rocks underlying the area are moderately to highly porous and permeable. Recharge is from seepage from streams and irrigation diversions. No stream enters the Snake River from the north side between Henrys Fork and Wood River, an airline distance of 160 miles. Through most of the year streamflow leaving the subsection in the Snake River is almost entirely ground-water effluent.

Payette Subsection

The Payette subsection consists essentially of two volcanic plateaus--an outer-older, and an inner-younger. The outer plateau is underlain by basaltic and silicic lava, pyroclastic rocks, and

volcanic sediments of Miocene to middle Pliocene age. The surface was faulted and downwarped into a broad, asymmetrical syncline along a northwesterly axis, with the steeper slopes on the north flank. In this syncline, basalt flows, pyroclastic rock, and tuffaceous sediments of late Pliocene and Pleistocene age accumulated in a band 20 to 40 miles wide, extending about from Bliss to Ontario. The Snake River has cut a canyon through these deposits at the eastern end of the subsection, but at the western end the Snake, Boise, and Payette Rivers have cut broad valleys, leaving such plateau segments as the Sailor Creek upland and the Mountain Home plateau. Pre-Tertiary rocks are exposed at a few places in the older plateau where local folding has uplifted the older rocks and subsequent erosion has exposed them.

Soils on the alluvial deposits are dominantly gravelly, sandy loams to clay loams. On the lacustrine deposits soils range from sandy loams to clay loams, and are compacted in the subsoil and substrata. Most of the soil on the younger volcanic rocks is wind-deposited fine sand or silt.

The younger basalt and the sand and gravel in the alluvium and lake beds are highly porous and moderately to highly permeable, and yield moderately large to large amounts of water. The older volcanic rocks have a low to medium porosity and perme-

Typical of the Snake River Plateau streams, the Owyhee River has cut a deep canyon through many levels of basalt flows. (Bureau of Land Management)

ability and yield small to moderate supplies. The pre-Tertiary rocks have low porosity and yield only small amounts of water.

Streams on the north side of the Snake River head in the Rocky Mountain section in areas where precipitation ranges from 25 to 50 inches annually. Aquifers in the Boise, Payette, Weiser, Malhuer, and Snake River valleys are recharged by influent seepage from streams and irrigation diversions. In turn, the major rivers receive, in their lower courses, large quantities of effluent seepage, partly irrigation return flow, that maintains a high summer and fall base flow. The area south of the Snake River is semi-arid, except for moderate rainfall on the few higher mountain ranges. Most of the smaller stream courses are high above the regional water table, and the streams are intermittent or ephemeral. Only the major trunk streams are below the regional water table and receive perennial inflow from ground water. Average annual runoff ranges from less than 1 inch to about 2 inches over most of the area.

C L I M A T E

The Columbia-North Pacific Region's climate is associated with the southerly and easterly drift of cyclonic storms that develop in the northern Pacific Ocean, and with the seasonal migration of the semi-permanent high pressure anticyclonic area of the Central Pacific. In winter, the storms pass over the region causing most of it to have distinctly wet winters. In summer, the storms swing farther north, resulting in relatively dry weather. In the interior, however, continental influences produce summer rains.

The general eastward movement of marine air masses keeps temperatures moderate most of the time. Occasionally, continental high pressure areas reverse the flow, sending dry air westward, hot in summer and cold in winter. Climatic data for selected stations are shown in table 2. More detailed data on climate are presented in Appendix V, Water Resources.

PRECIPITATION

Two major factors generally affect precipitation, the moisture supply (the Pacific Ocean) and elevation. Regardless of elevation, however, the western parts receive by far the most precipitation. At the same distance from the ocean, the higher mountains receive more than the valleys and plateaus. Inland, and at higher elevations, a large percent of the total precipitation occurs as snow (see figure 7).

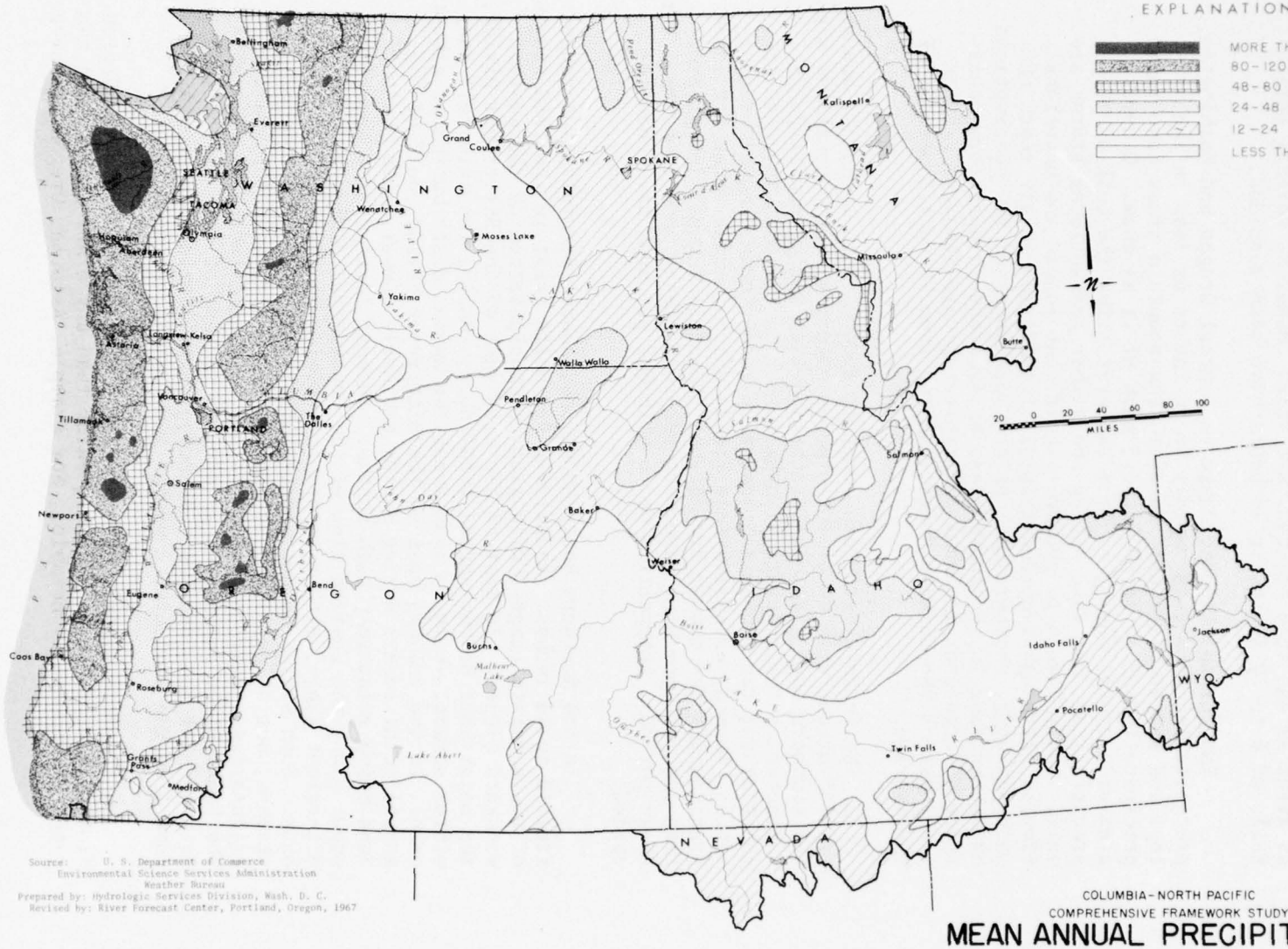
The heaviest annual precipitation in the conterminous United States occurs on the western slopes of the Coast and Cascade Ranges, exceeding 200 inches in the Olympic Mountains. From the crest of the Coast Range, annual precipitation decreases to about 35 inches in the Puget Sound-Willamette Trough, then increases again to 100 inches or more along the crest of the Cascade Range. Nearly all precipitation comes with storms moving in from the ocean, and about two-thirds of the year's total falls during the October to March period. At lower elevations, it is largely rain, but in the mountains, snow. Heavy snowpacks on many of the higher mountains have formed glaciers which are the sources of several rivers. Maximum snowpacks, occasionally to depths of 20 to 30 feet, are generally found at elevations above 5,000 feet, and their water content usually is greatest in late March and early April. The greatest amount of cumulative snowfall recorded during a winter season in the United States is 1,000 inches at Paradise Ranger Station on Mount Rainier. Variations in annual precipitation range from about 60 to 150 percent

TABLE 2 - CLIMATIC DATA FOR SELECTED STATIONS, COLUMBIA-NORTH PACIFIC REGION

Average monthly temperature in degrees Fahrenheit and precipitation in inches for period 1931-60.
Other data covers varying lengths of record.

STATION AND ELEVATION	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	YEAR	AVERAGE ANNUAL SNOWFALL	DAYS WITH 0.1 INCH PRECIP.	TEMP. EXTREMES Low	TEMP. EXTREMES High	AVG. FROST-FREE SEASON (32°F) 1st Day	AVG. FROST-FREE SEASON (32°F) Last Day	AVG. FROST-FREE SEASON (32°F) Total Days
Albany, Oregon 212	39.4 6.2	42.9 5.1	46.7 4.6	52.2 2.3	57.5 2.1	62.1 1.5	67.1 0.4	66.5 0.5	62.3 1.4	53.9 4.0	45.3 5.9	41.8 5.7	53.1 40.7	7.6	96	-15	104	Mar. 30	Nov. 6	221
Bellingham, Washington 120	36.8 4.2	39.5 3.2	43.0 3.1	48.0 2.3	53.2 1.8	57.8 1.9	61.0 1.0	60.6 1.1	56.7 2.0	50.1 3.6	43.1 4.5	39.6 4.9	49.1 33.6	9.7	93	-4	97	May 12	Sept. 30	141
Bend, Oregon 3599	30.2 1.8	33.9 1.1	38.3 0.8	44.6 0.7	50.7 1.1	56.4 1.2	63.7 0.5	62.2 0.4	56.3 0.4	47.8 0.9	38.5 1.4	33.3 1.7	46.3 12.0	36.1	30	-26	104	June 20	Aug. 3	125
Boise, Idaho 2841	29.1 1.3	34.5 1.3	41.7 1.3	50.4 1.2	58.2 1.3	65.8 0.9	75.2 0.2	72.1 0.2	62.7 0.4	51.6 0.8	38.6 1.2	32.2 1.3	51.0 11.4	21.2	36	-17	111	May 6	Oct. 12	159
Brookings, Oregon 80	47.1 13.1	48.0 11.1	48.9 10.2	51.1 5.4	54.6 4.3	57.7 2.5	58.9 0.6	58.9 0.6	59.5 1.8	56.0 7.3	51.7 10.7	48.8 13.8	53.4 81.4	0.7	102	17	100	Feb. 20	Dec. 15	298
Burns, Oregon 4151	24.8 1.6	29.7 1.3	37.4 1.0	46.0 0.7	53.4 0.9	59.8 0.9	69.5 0.3	67.2 0.3	58.8 0.5	48.4 0.9	36.1 1.2	29.1 1.4	46.7 11.0	48.0	36	-25	103	June 6	Sept. 19	105
Centralia, Washington 185	39.2 6.4	42.1 5.4	45.4 4.7	51.0 2.7	56.5 1.9	60.5 1.9	65.1 0.7	64.4 1.0	60.6 1.9	53.0 4.5	44.8 6.7	41.6 7.7	52.0 45.5	10.6	116	-16	105	Apr. 24	Oct. 19	178
Crater Lake, Oregon 6475	25.3 10.6	26.6 8.3	28.7 7.5	34.2 4.6	40.5 3.2	47.5 2.5	56.2 0.7	55.6 0.7	49.3 2.2	41.5 5.6	33.5 7.9	27.5 10.9	38.9 64.7	521.3	110	-20	100	---	---	---
Ephrata, Washington 1275	26.4 1.0	33.2 0.7	43.5 0.7	53.0 0.6	61.8 0.7	68.5 0.9	76.7 0.2	74.5 0.2	65.5 0.5	53.8 0.8	39.0 1.0	30.5 1.1	52.2 8.4	17.8	31	-23	113	Apr. 16	Oct. 13	180
Hart Mt. Refuge, Oregon 5555	27.0 0.8	30.3 0.8	33.6 1.0	40.9 0.7	47.4 1.8	53.3 1.5	62.6 0.4	61.2 0.3	54.9 0.5	46.0 1.0	36.2 0.8	31.0 0.8	43.7 10.4	60.6	34	-23	98	June 24	Aug. 2	39
Helena, Montana 3893	18.6 0.5	23.2 0.4	31.4 0.7	43.3 0.8	52.9 1.6	59.5 2.2	68.4 1.0	66.2 0.9	56.0 1.0	45.6 0.7	31.6 0.6	24.2 0.5	43.4 10.9	45.0	30	-42	103	May 12	Sept. 23	134
Kalispell, Montana 2965	19.8 1.4	24.5 1.0	31.8 1.0	43.7 1.0	52.2 1.7	58.6 2.2	65.7 1.0	63.1 1.1	54.7 1.0	43.9 1.3	31.0 1.4	25.0 1.3	42.8 15.4	67.8	50	-38	104	May 12	Sept. 23	134
Kellogg, Idaho 2305	27.2 3.6	31.5 2.9	38.1 3.0	47.0 2.4	55.1 2.4	60.8 2.4	68.2 0.9	66.1 0.8	58.6 1.7	48.4 3.2	36.3 3.7	31.2 4.0	47.4 31.0	58.7	96	-27	109	May 12	Sept. 27	138
Klamath Falls, Oregon 4098	29.4 2.1	33.8 1.6	39.5 1.2	46.9 0.8	53.7 1.2	60.1 1.0	68.7 0.3	66.9 0.3	60.4 0.6	50.0 1.2	38.5 1.6	32.2 2.2	48.3 14.1	41.0	42	-24	105	May 25	Sept. 28	126
Lewiston, Idaho 1413	30.7 1.1	35.9 1.0	42.6 1.2	50.8 1.1	58.4 1.6	64.8 1.7	73.8 0.4	71.7 0.4	63.5 0.9	52.0 1.2	39.8 1.2	34.9 1.4	51.6 13.2	17.7	40	-22	109	Apr. 21	Oct. 17	179
Medford, Oregon 1312	35.4 3.1	40.1 2.4	44.3 1.8	50.6 1.1	57.5 1.5	64.2 1.0	72.0 0.2	70.7 0.2	64.2 0.6	53.0 1.9	42.4 2.6	36.9 3.4	52.6 19.8	7.6	49	1	115	Apr. 23	Oct. 24	184
Missoula, Montana 3200	19.2 0.9	25.0 0.9	33.7 0.7	44.3 1.0	52.6 1.9	58.5 1.9	67.0 0.8	64.8 0.7	55.4 1.0	44.0 1.0	30.5 0.9	23.5 1.1	43.2 12.8	43.2	44	-33	105	May 14	Sept. 15	124
Moscow, Idaho 2660	28.2 2.8	32.5 2.2	38.9 2.1	47.1 1.7	54.4 1.6	60.0 1.7	67.3 0.5	65.6 0.5	59.2 1.2	49.5 2.0	37.8 2.7	32.4 3.2	47.7 22.2	46.9	67	-30	105	May 12	Sept. 23	134
North Head, Washington 194	41.9 8.4	43.3 7.2	45.2 5.8	48.2 3.9	51.6 2.8	55.0 2.2	57.5 1.0	58.2 1.1	56.9 2.9	53.5 5.2	48.3 8.0	44.2 9.4	50.3 57.9	5.2	119	11	97	Feb. 3	Dec. 20	320
Oroville, Washington 1060	25.8 1.1	30.8 0.9	41.2 0.7	51.6 0.8	59.6 0.9	66.0 1.4	72.9 0.7	70.8 0.7	62.1 0.7	50.0 1.0	37.4 1.3	29.9 1.2	49.8 11.4	24.6	39	-19	111	Apr. 29	Oct. 9	163
Pendleton, Oregon 1492	32.2 1.4	37.4 1.2	45.1 1.2	52.0 1.1	59.6 1.1	65.8 1.2	73.6 0.2	71.9 0.3	64. 0.6	53.7 1.2	41.3 1.4	36.5 1.5	52.8 12.4	18.5	42	-22	110	Apr. 27	Oct. 6	162
Pocatello, Idaho 4444	22.3 1.2	27.2 0.9	35.8 1.0	46.5 1.1	55.1 1.1	62.8 1.0	72.4 0.5	70.1 0.6	60.3 0.6	49.1 0.9	35.0 1.0	27.4 1.0	47.0 10.9	36.2	30	-31	103	May 10	Sept. 29	142
Portland, Oregon 30	40.2 6.3	43.8 4.9	47.7 4.8	53.5 2.5	59.1 2.1	63.4 1.7	68.6 0.4	68.1 0.7	64.5 1.7	56.5 3.9	47.2 6.0	43.1 7.4	54.6 42.4	12.4	103	-2	107	Feb. 22	Dec. 3	284
Roseburg, Oregon 505	40.3 5.5	43.3 4.2	46.6 3.4	51.5 1.9	56.5 1.9	61.5 1.5	67.9 0.2	67.6 0.3	62.8 1.0	54.4 3.0	46.1 4.5	42.0 5.7	53.4 33.1	6.7	74	-6	109	Apr. 5	Nov. 10	219
Salmon, Idaho 3949	17.9 0.6	24.7 0.5	35.1 0.5	45.7 0.6	53.9 1.4	60.2 1.3	67.8 0.8	65.6 0.6	56.6 0.7	45.8 0.7	31.8 0.6	22.5 0.6	44.0 8.9	19.7	33	-37	106	June 5	Sept. 10	97
Seattle, Washington 14	41.2 5.2	43.6 3.9	46.4 3.3	51.8 2.0	57.4 1.6	61.4 1.4	65.6 0.6	65.0 0.7	61.2 1.7	54.4 3.3	46.9 5.0	43.8 5.4	53.2 34.1	11.4	91	3	100	Mar. 23	Nov. 18	240
Sequim, Washington 180	37.9 2.2	40.1 1.7	42.8 1.3	47.8 0.9	53.1 1.0	57.2 1.1	60.4 0.5	60.8 0.6	57.4 0.9	50.6 1.6	43.6 2.3	40.2 2.7	49.3 16.8	16.0	53	-3	99	Apr. 23	Oct. 27	187
Snoqualmie Pass, Wash. 3020	26.3 14.6	28.9 12.0	34.4 11.1	40.6 5.9	46.2 4.4	51.2 4.1	57.8 1.4	57.2 2.2	52.7 4.5	44.1 9.4	33.6 13.5	28.9 17.2	41.8 100.3	419.8	153	-17	101	---	---	---
Spokane, Washington 2357	25.3 2.4	30.0 1.9	38.1 1.5	47.3 0.9	56.2 1.2	61.9 1.5	70.5 0.4	68.0 0.4	60.9 0.8	49.1 1.6	35.7 2.2	30.1 2.4	47.8 17.2	58.0	57	-24	102	Apr. 20	Oct. 12	175
Tatoosh Island, Wash. 101	42.0 10.8	43.1 8.7	44.2 8.4	47.5 5.2	51.1 3.0	53.9 2.8	55.5 2.3	56.0 2.0	54.8 3.6	51.9 8.2	47.2 10.5	44.4 12.2	49.3 77.7	8.2	135	7	88	Feb. 1	Dec. 20	322
The Dalles, Oregon 102	33.9 2.5	39.0 1.8	46.4 1.4	54.2 0.5	61.5 0.6	67.4 0.7	73.7 0.1	72.3 0.2	66.0 0.5	55.2 1.2	42.9 2.0	38.0 2.3	54.2 13.8	23.5	40	-30	115	Apr. 3	Oct. 29	209
Twin Falls, Idaho 3770	27.3 1.0	32.7 0.7	39.9 0.8	49.2 0.9	57.4 1.0	64.4 0.8	72.9 0.2	69.9 0.2	61.3 0.5	51.0 0.8	38.1 0.9	31.6 0.9	49.6 8.7	20.5	28	-30	106	May 13	Sept. 23	133
Yakima, Washington 1061	27.5 1.2	34.0 0.9	42.0 0.6	50.5 0.5	58.5 0.5	64.4 0.8	71.0 0.1	68.6 0.2	61.3 0.4	50.5 0.6	37.4 1.0	31.5 1.1	49.8 7.9	25.2	28	-25	105	Apr. 28	Oct. 12	167

SOURCE: U. S. Department of Commerce, Weather Bureau, Climatography of the United States No. 86 Series, Decennial Census of United States Climate, Supplement for 1951 through 1960.



Source: U. S. Department of Commerce
Environmental Science Services Administration
Weather Bureau
Prepared by: Hydrologic Services Division, Wash. D. C.
Revised by: River Forecast Center, Portland, Oregon, 1967

COLUMBIA - NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL PRECIPITATION IN INCHES THE REGION

1968

FIGURE 7

of average. Despite high total precipitation, hourly intensities as great as one inch per hour are rare. However, several rainfalls of 6 to 12 inches in 24 hours have been recorded.

East of the Cascade Range in central Oregon and Washington, precipitation decreases rapidly to 10 inches or less in the valleys and on the plateaus. However, the mountain areas have total precipitation of 40 to 50 inches, much of it as snow. General area-wide storms moving in from the west bring the bulk of the precipitation, but late spring and summer convectional storms are sufficiently common to produce significant runoff and occasional floods. Although recorded rainfall intensities rarely reach one inch per hour, weather stations are scattered and few observations have been made in the known areas of frequent thunderstorm occurrence. Variations in annual precipitation are somewhat greater than west of the Cascade Range, ranging from 50 to 165 percent of the average.

The Snake River Plain receives from 6 to 15 inches of annual precipitation, with 40 or more inches occuring in the mountains along the southern edge. Both midwinter and late spring runoff peaks characterize the precipitation pattern. On the eastern edges of the Plateau, the mountains receive up to 40 inches annual precipitation, forming extensive snow fields which furnish water for lower areas during the summer dry season. Rainfall intensities greater than one inch per hour have been recorded during summer storms. For short periods, intensities up to 6 inches per hour have been recorded.

In the Northern Rocky Mountains, annual precipitation ranges from 10 to 70 inches. Relatively dry belts exist in the rain shadows of the mountain ranges, with greater precipitation on the western windward slopes. In most of the area west of the Bitterroot Divide, the major part of the annual total occurs during the late fall and winter season, while in some areas the annual distribution is almost even. In the valleys east of the Bitterroot Divide, half of the annual total occurs during spring and early summer, with May and June being relatively high months. Intense local storms sometimes occur along the western side of the Continental Divide and the Bitterroot Range, with recorded intensities as great as 2 inches an hour. Such storms do not greatly affect the flow of the major streams, but do occasionally produce flash floods in the smaller tributaries. Year-to-year variation in precipitation in this and the Snake River Basin area is similar to that of the rest of the area east of the Cascades. Principal contributions to streamflow come from the accumulated winter snowpack in the mountains.

Figure 8 clearly shows seasonal variations across the Region. Winter quantities are always greater than any other season, but the range in amounts is notable. For example, Astoria, Oregon, receives

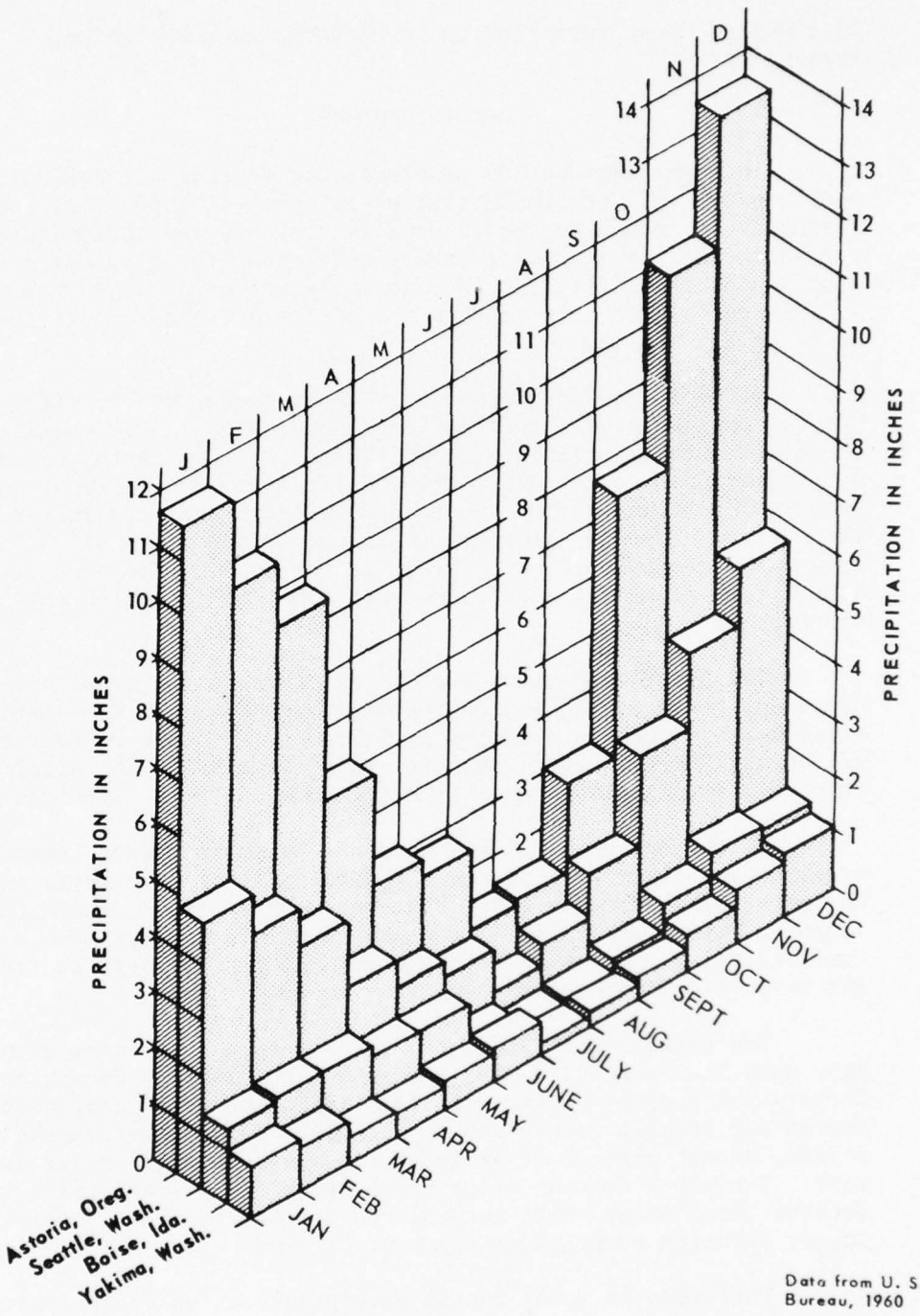


FIGURE 8. Seasonal Distribution in Precipitation in the Columbia-North Pacific Region.

13 times as much precipitation in December as does Yakima, Washington.

DROUTH PERIODS

An important feature of climate, affecting all agricultural and forestry and some industrial operations, is the extent and frequency of drouth periods. Usually a drouth may be considered a relative matter in that rainfall sufficient for a normally dry area would be insufficient in a normally wet area. The "relative" definition is used here to show the differences between various parts of the region.

West of the Coast Range, dry months occur nearly every year, but two-month dry periods occur only about once in ten years. In the Willamette-Puget Sound Trough, there is a dry month, usually July or August, nearly every year; a two-month drouth about one year in three; and a three-month drouth about one year in ten. The Cascade Range has similar drouth occurrences. In all of these areas, the drouths are more severe to the south. There rarely is enough rain from late June to mid-September to replenish soil moisture.

The Columbia Plateau and Oregon Closed Basin areas are very dry. One-month drouth periods occur every year, and two-month or three-month drouths are nearly as frequent. Drouths of four to six months' length occur from once in four years in the drier parts, to once in ten years in the higher or more northerly sections.

In the Northern Rocky Mountains, one-month drouth periods occur nearly every year, two-month drouths about five years in ten, and three-month drouths only about one year in ten. Drouths of longer duration are rare. The higher mountain valleys have a more humid climate; one-month drouths occur about five years in ten, and two-month drouths about one year in ten.

The Snake River Plains and the bordering mountains normally have such low rainfall during the summer months that drouth conditions are typical of the climate. Although summer convectional storms may locally reduce drouth frequency during the growing season, drouth periods of at least a month's duration occur every year. Two-month drouths occur about every other year, three-month drouths about three years in ten, and drouths of four months or longer duration occur about two years in ten.

Variation in total annual precipitation, entirely apart from seasonal drouth occurrence, also affects water supplies. Dry years with less than two-thirds of normal precipitation occur about once in thirty years along the coast, about once in twenty years in the Willamette-Puget Sound Trough, once in thirty years in the Cascade

Range, once in fifteen years in the Columbia Plateau and Oregon Closed Basin areas, once in five years in the Snake River Plain, and once in twenty years in the Northern Rocky Mountains. Dry years may come in groups; the period 1929-31 was abnormally dry over most of the region. In the years 1889, 1905, 1915, 1920, 1924, 1926, 1937, 1941, 1944, and 1967, streamflows were generally low.

TEMPERATURE

West of the Cascade Range, temperatures in the lower lying areas range from a January average of 36° F. to a July average of 62° F. The frost-free season ranges from 200 to 240 days in length, covering the period April to November. Mountain areas are colder year-round and have a much shorter growing season. Figure 9 shows the average frost-free growing season, and figure 10 shows the mean annual temperature. Seasonal variations in mean daily temperature are about 15° F. along the coast, and 25° and 30° F. in the interior valleys and in the mountains. Daily temperature ranges are about 15° F. in the winter season and 20° to 25° F. in summer. Except in the southern part, temperatures above 100° F. are rare. Temperatures below 0° F. have occurred, but in the lower valleys temperatures below 10° F. are unusual.

East of the Cascade Range, temperature patterns are quite different. Average January temperature ranges from 20° F. in the mountains to 32° F. in the warmest valley areas, and average July temperature similarly ranges from 60° F. to 76° F. Daily range in temperature varies 15° to 30° F. in January, and 30° to 50° F. in July. Seasonal range in mean daily temperature is about 40° F. At most stations, temperatures well above 100° F. have been recorded in summer, and temperatures of -30° F. are fairly common in winter, with some below -50° F. having been recorded. In the mountains and in the Oregon Closed Basin, the frost-free growing season is generally less than 100 days, extending from mid-June to mid-September. In the valleys and on the Columbia Plateau, the frost-free season is 140 to 200 days long, from late April to late September.

The Snake River Plain has a temperature regime similar to that of the plateau areas to the west. January average temperatures range from 12° F. in the northern and eastern parts to 34° F. at the western end. Temperatures below zero are recorded almost every year. Lowest temperature recorded is -63° F. in the mountains on the eastern edge of the region. On the plain, the lowest of record is -46° F. July average temperatures range from 55° F. in the mountains, to 78° F. in the valley areas. Seasonal range in daily temperature is about 50° F. Temperatures to 118° F. have been recorded in summer. The frost-free growing season ranges from 40 days in the mountains around the rim to 180 days in the western valleys. Some mountain stations have recorded frost in every month. Most of the agricultural area has a growing season of 120 to 140

days, extending from the first week in May to the last week in September. The warmest part of the area has a growing season of 180 days.

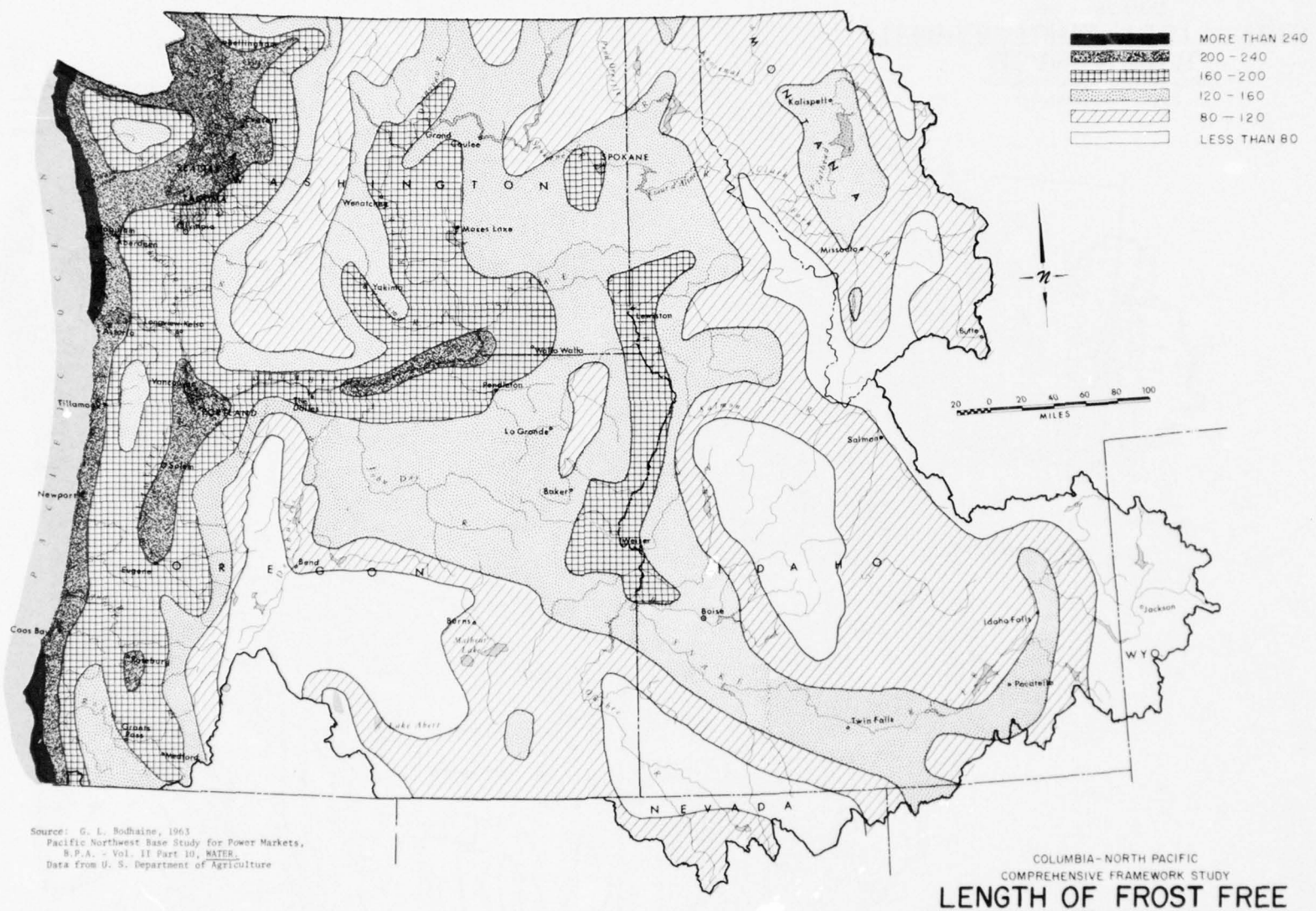
At lower elevations on the western side of the Northern Rocky Mountains, the average annual temperature is about 50° F., but at the higher elevations in the interior, it is less than 40° F. Average January temperature ranges from below 20° F. in the mountains to just above freezing in the lowermost western part. Average July temperature similarly ranges from 60° F. to 75° F. Lowest temperature of record is -52° F. at the eastern edge of the area. Below zero temperatures occur nearly every year throughout the area. Seasonal range in temperature is greater than 40° F. Daily range varies from 5° to 30° F. in January, and from 20° to 50° F. in July. Temperatures above 115° F. have been recorded at some stations; over 100° F. at nearly all stations. The frost-free growing season in the mountain valleys averages from 80 to 150 days long, increasing to 200 days in the lower elevations at the western edge of the area. Generally, the frost-free season extends from mid-May to mid-September, although in the higher mountains frost may occur in every month of the year.

There is a similarity of the temperature pattern over the region, with all stations showing strong seasonal differences from summer to winter. For stations west of the Cascades, all months average well above freezing, while eastward two to four of the winter months usually average below freezing. The variation between summer and winter temperatures in the eastern part of the basin is much greater than in the sections nearer the coast.

Figure 9, with isopleths for length of frost-free growing season, shows lines of equal duration of season in which crops may be grown. The shortest seasons are found in the mountain areas, longest seasons near the coast.

WIND, EVAPORATION, AND TRANSPIRATION

Although average wind velocities only range from 4 to 16 miles per hour at the various stations, maximum velocities of over 100 miles per hour have been recorded all along the coast. These hurricane-force windstorms do considerable damage to timber stands, public utilities, and industrial developments. Such high winds do not normally occur in the Puget Sound-Willamette area, although occasionally there is serious wind damage during the winter season. The most spectacular occurrence was the Columbus Day storm in 1962. Cold winds from the north and east often bring midwinter periods of below-freezing weather, while warm winds from the west and southwest accompany fall and winter storms. Warm winds in the spring season are a factor in melting the snow accumulated in the



Source: G. L. Bodhaine, 1963
Pacific Northwest Base Study for Power Markets,
B.P.A. - Vol. II Part 10, WATER.
Data from U. S. Department of Agriculture

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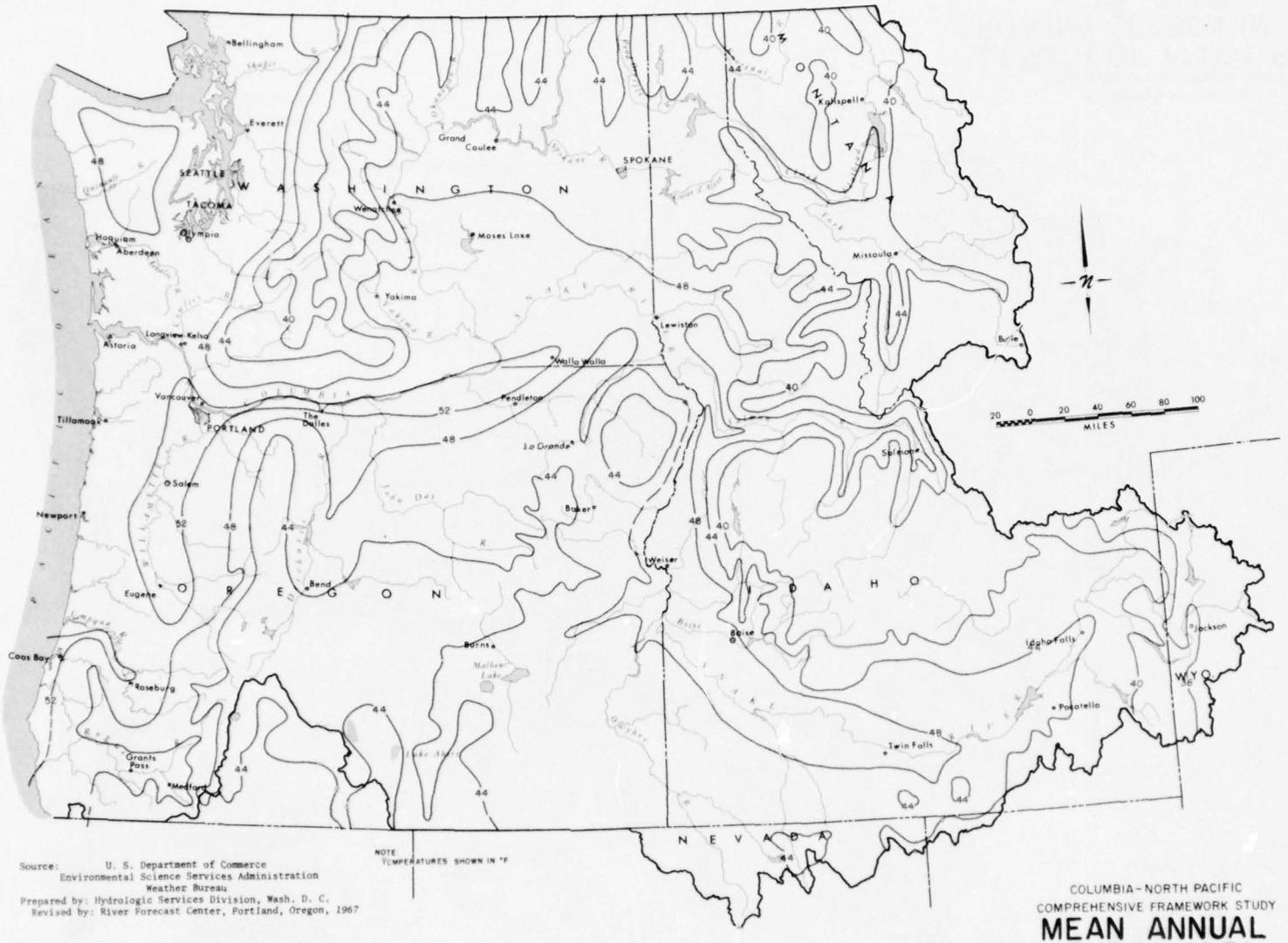
LENGTH OF FROST FREE GROWING SEASON IN DAYS

THE REGION

1968

FIGURE 9



Source: U. S. Department of Commerce
Environmental Science Services Administration
Weather Bureau
Prepared by: Hydrologic Services Division, Wash. D. C.
Revised by: River Forecast Center, Portland, Oregon, 1967

NOTE
TEMPERATURES SHOWN IN °F

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL TEMPERATURES 1931 – 1951
THE REGION
1968

FIGURE 10

mountains during the winter. Hot, dry winds from the east in summer and fall cause the humidity to drop very low and bring on periods of extreme fire danger. Such conditions are also responsible for extensive damage to crops and range forage, and greatly increase the use of irrigation water.

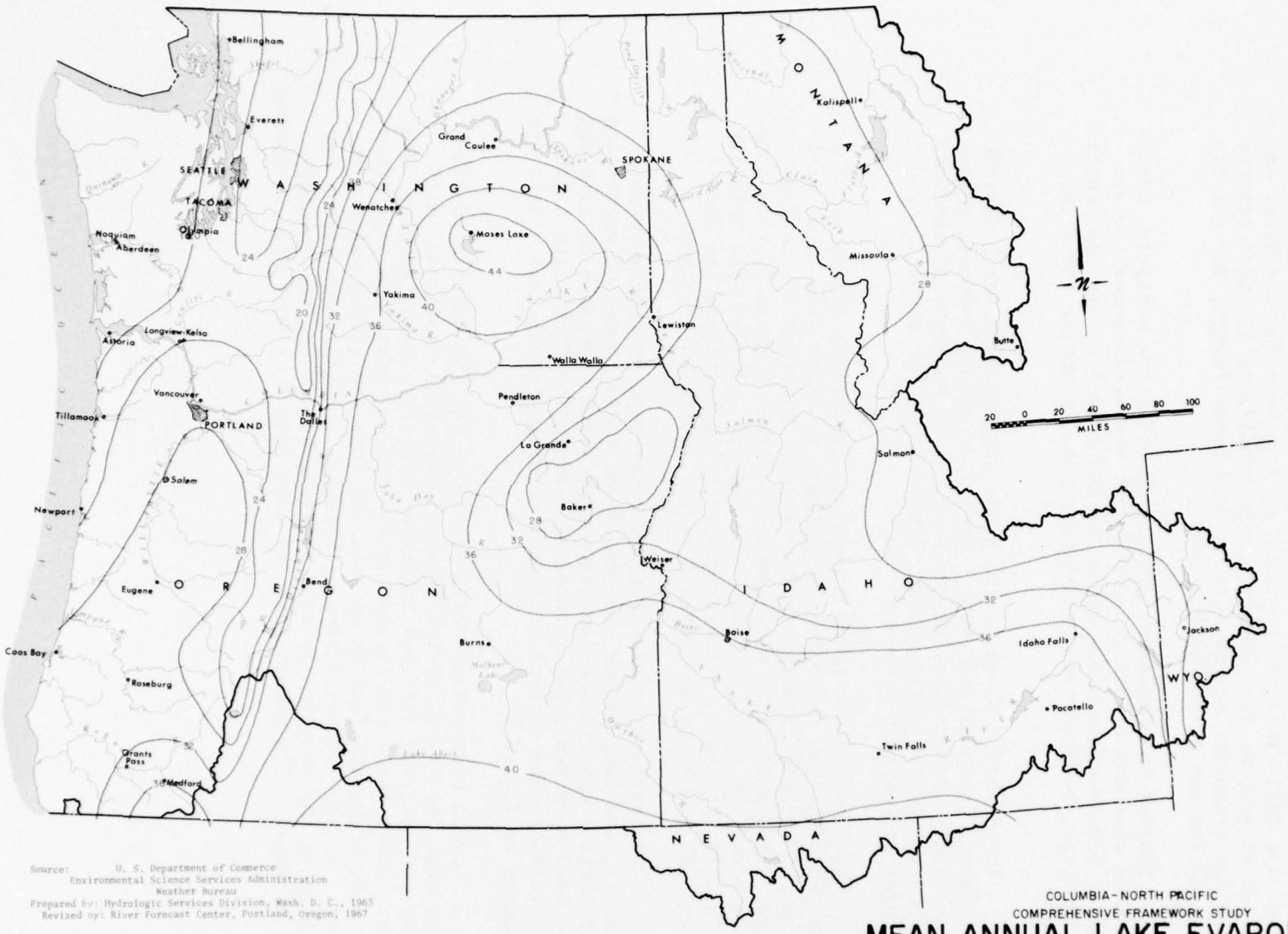
East of the Cascades, prevailing winds are westerly. Greatest wind movement occurs in spring, but the winds generally are light. Severe winds occur along the Columbia River in the center of the area, occasionally causing dust storms during the drier months.

In the Snake River Plain, winds occasionally reach destructive forces in localized areas. Over wide areas, however, velocities rarely exceed 40 miles per hour. Wind movement is greatest in late winter and early spring, lowest in summer and fall, and averages from 6 to 9 miles per hour.

In the Northern Rocky Mountains, prevailing air movement is from the west, but the broken topography provides wide local variations in the direction of surface winds. Although the mountain ranges tend to moderate wind movement, rather high velocities sometimes occur for short periods. The highest recorded wind velocity is 72 miles per hour, but averages at valley stations are from 6 to 9 miles per hour; on mountain ridges, it is much higher.

Evaporation, which is strongly affected by wind movement, humidity, and temperature, is one of the major causes of water loss. Only limited observations on evaporation from snowpacks or from the soil have been made, but records of evaporation from class A pans are available for several stations. Average annual lake values are depicted on figure 11.

Lowest evaporation rates are those for the humid mild climates near the coast, or for high cold mountain stations. High rates for interior stations indicate warm, dry, sunny growing seasons. Under these conditions, transpiration rates from vegetation are also high, and demands on soil moisture and ground water are great. On the watershed slopes, however, transpiration losses are limited to the supplies of soil moisture held over from rainfall and snowmelt. The amount lost may vary from 2 to more than 20 inches.



Source: U. S. Department of Commerce
Environmental Science Services Administration
Weather Bureau
Prepared by: Hydrologic Services Division, Wash. D. C., 1965
Revised by: River Forecast Center, Portland, Oregon, 1967

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

MEAN ANNUAL LAKE EVAPORATION IN INCHES, 1946 - 1955
THE REGION
1968

FIGURE 11

NATURAL RESOURCES

N A T U R A L R E S O U R C E S

The term, Natural Resources, for the purpose of this study, has been defined to include only the basic resources of water, land, and minerals.

WATER RESOURCES

Water Sources

The water supply in the Columbia-North Pacific Region arrives as precipitation (mostly from eastward-moving air masses off the Pacific Ocean) and as streamflow from Canada. Much of the water is stored temporarily as snow and ice on the ground, in ground-water reservoirs, and in lakes and surface reservoirs, before flowing back to the sea. The water ultimately discharges into the Pacific Ocean, or returns to the atmosphere by evaporation or transpiration.

Annual precipitation averages about 28 inches over the region. About 12 of the 28 inches return directly to the atmosphere through evaporation and transpiration; 16 inches become runoff. Of the runoff, about 2 inches are withdrawn by man for domestic, industrial, and agricultural uses and, of this, less than 1 inch is consumed. The remaining 15 inches of runoff are used for recreation, fish and wildlife, power production, navigation, waste transportation, and dilution of waste discharge. Stream inflow from Canada, equivalent to another 3 inches of water over the region, is also available for use.

Water, a basic element in the Region's settlement, development, and prosperity.

Precipitation varies considerably throughout the region. Western Washington averages 70 inches and boasts of having the wettest spot in the conterminous United States, the Olympic Mountains where precipitation exceeds 200 inches. East of the Cascade Range in Washington, the average is 19 inches, and for the entire State it is 40 inches. Oregon is a little drier with averages of 53 inches for western Oregon, 15 inches for the east side, and 27 inches for the State. Western Montana, with 19 inches of precipitation, is similar to eastern Washington, while Idaho has an average of 22.5 inches. Although amounts of precipitation and streamflow differ greatly from time to time and from place to place, available data do not indicate either an upward or downward long-term trend or a long-term cycle of either precipitation or river discharge. Average discharge in the future, except for increases in depletion by consuming uses, is assumed to remain about the same. East of the Cascade Range most of the runoff occurs during the snowmelt period, April-July; west of these mountains, the runoff closely follows the winter rainfall pattern--high in winter and low in summer. During late summer and early autumn, streamflow consists principally of ground-water discharge to the stream channels.

New techniques in finding, developing, or using water supplies will make available additional supplies that may be needed to help meet the increasing demand for water. More efficient use of available supplies is expected through multiple-use projects, reuse and recycling of water, improved efficiency in the transport and application of irrigation supplies, and improved hydrometeorologic forecasting.

Additional firm supplies of fresh water probably will be made available through improved use of the water resources, including conjunctive use of surface and subsurface supplies; improved construction and use of wells to develop ground water that is not now considered to be an economic supply; and greater use of salt water in place of fresh water for some industrial requirements. Additional economically competitive supplies possibly can be developed by means of weather modification, vegetative management and desalination; however, the practical utility of these methods in the Columbia-North Pacific Region has not yet been proved.

Water Availability

Average discharge from the region, including 69,000 cfs (cubic feet per second) inflow from Canada, is about 356,000 cfs or 257 million acre-feet per year for the period 1929-58. Approximately 20 percent of the average flow originates in Canada. Much of this discharge can be made available for use, but only with additional storage because of the great variability in runoff in

both time and place.

Water availability may be defined as the water available on a percentage basis, such as 80, 90, or 95 percent of the time. Including water originating in Canada, the Columbia-North Pacific Region would have about 245,000 cfs available 80 percent of the time; 203,000 cfs, 90 percent of the time; and 180,000 cfs, 95 percent of the time.

Records show that the average discharge of 178,000 cfs in the base period 1929-58 for the Columbia River at The Dalles, Oregon, is 91 percent of the long-term (87-year) average. For streams west of the Cascade Range, the base-period average discharges are nearly 100 percent of the long-term means. These figures indicate that the long-term average discharge for the region may be 5 percent greater than the base-period average of 353,000 cfs.

In spite of the apparent large total supply, water is not always available where and when it is needed to meet requirements. Extreme variations occur in the areal distribution of annual runoff. In the western part of the region, large amounts of precipitation generate an average annual runoff that exceeds 100 inches in a substantial area of the Coast and Cascade Ranges. In contrast, runoff averages less than 1 inch per year in much of eastern Washington, eastern Oregon, and southern Idaho. Annual runoff greater than 40 inches is rare in any area east of the Cascade Range. In addition to the uneven distribution of runoff from one location to another, large variations in streamflow occur on a monthly, yearly, and long-term basis.

West of the Cascade Range the major part of the runoff occurs in winter and is closely related to precipitation. High water in winter results from rain at lower elevations, and rain on snow at higher elevations. At the higher elevations, low flows occur in winter due to snow accumulation and high flows in summer as a result of snowmelt.

East of the Cascade Range, various conditions such as melting snow on lower elevation plateaus in early spring, melting mountain snowpacks in summer, or local thunderstorms in summer, cause the greater part of the annual stream discharge to occur in spring and early summer.

Annual runoff varies considerably from year to year. It is a fallacy to assume that the average discharge of a large stream or a subregion is the available supply. Even with storage, the total mean discharge cannot be obtained for use because of natural losses and year-to-year variations. In most streams, the minimum year of discharge provided only about 60 percent of the average annual flow;

also, the mean of the minimum five consecutive years supplied only about 75 percent of average. There are some large streams in a few subregions that produce minimum year flows as low as 25 percent of the long-term average.

A large amount of water is lost by evaporation from exposed water surfaces, although the magnitude of the loss may not be obvious because it is usually small when compared to total precipitation. Its toll is not taken directly from precipitation, however, but from the smaller quantity of water that finds its way to the streams, lakes, and surface reservoirs, the principal sources for man's needs in many localities. Evaporation losses attain special importance in the arid portion where evaporation alone from the closed-basins area has been estimated to average 770,000 acre-feet annually. Studies by the Geological Survey indicate that in 1960 about 3.3 million acre-feet evaporated from principal reservoirs and regulated lakes.

Major aquifers capable of yielding moderate to large volumes of water underlie about one-fourth of the Columbia-North Pacific Region. In most of the remainder of the area, small to moderate supplies of ground water can be obtained. The major ground-water reservoirs generally are located in three kinds of geologic terranes; predominantly volcanic, predominantly sedimentary, and combined volcanic and sedimentary. Many wells that tap the major aquifers yield several thousand gallons per minute. Thus, the aquifers must be considered economic sources of supplies for irrigation, industrial, and municipal uses. In only a few local areas is use approaching the limit of available supply.

Some large bodies of saturated permeable rocks are at such high altitudes, or great depths, or in such rugged terrain that immediate development is unlikely. At many places, as in the Cascade Range in Oregon and southern Washington, these remote aquifers supply large quantities of water to streams. Ground water generally contributes from 15 to 40 percent of the water discharged by streams, but may be nearly 100 percent in some streams.

Glaciers are of practical importance to the water resources both because of their volume and the time of year when they produce streamflow. About 83 percent of the glacier-covered area in the conterminous United States lies in the Columbia-North Pacific Region. The estimated volume of these glaciers is 46 million acre-feet, of which about 96 percent is in Washington--mostly in the northern part of the Cascade Range. Glaciers retain a large portion of the precipitation that falls on them during the wet winter season and release the water during the hot, late-summer season when it is most needed. Also, during wet, cold years when not as much water is required by irrigators and other consumers, glaciers tend to accumulate precipitation and to grow; during the hot, dry years

they tend to release more water. In 1960, Meier (4-420-429) estimated that the average annual runoff from glaciers amounted to 13 cubic feet of water from each square foot of glacier area. On that basis, glaciers contribute about 1.4 million acre-feet of water annually. An important fact is that nearly two-thirds of this water is released during the months when precipitation is low.

Water Quality

Regionally, water quality is generally very good, with large quantities of relatively unpolluted surface water available, although significant water-quality problems do exist in various parts of the region. Average dissolved-solids concentrations are less than 300 mg/l (milligrams per liter) in major surface-water supply sources, and only in a few small areas does the dissolved solids content exceed 1,000 mg/l.

The extent of salt water intrusion in streams discharging into Puget Sound or the Pacific Ocean has not been precisely determined. Recent measurements, however, indicate that at times salt water in the Columbia River estuary extends upstream past Astoria to a point about 23 miles from the mouth, almost to Harrington Point.

Mountain streams generally have a dissolved-solids concentration of less than 100 mg/l and many have less than 50 mg/l. In contrast, concentrations landlocked in lakes in the Oregon Closed Basins range from less than 1,000 mg/l to 70,000 or more mg/l. The dissolved-solids content of these closed lake waters is dependent upon amount of inflow, lake volume, evaporation, seepage loss, and type of soil.

Return flow from irrigation is a major factor in increasing the dissolved-solids content of the receiving surface water. An extreme example is in the lower Malheur River in Oregon where the concentration increases from less than 250 to more than 1,200 mg/l during the irrigation season, largely attributable to irrigation return flow, and a relatively small amount of receiving water. Another serious local pollutant is the sulfite waste material produced by the pulp and paper industry.

Most surface water in the region is chemically suitable for domestic use, and for most industrial, agricultural, and other uses. Manufacturers requiring low concentrations of silica would need to treat the water, however, because many streams have silica concentrations greater than 10 mg/l. The presence of nitrate and phosphate from both natural and man-made sources causes excessive algal growth in several areas east of the Cascade Range. Low dissolved-oxygen concentration is a seasonal problem in segments of some streams. Bacterial concentrations seasonally exceed

desirable levels in the lower Willamette and Columbia Rivers and in reaches of many other streams below major communities. During the summer months, water temperatures in many streams rise to levels undesirable for native and anadromous fish life.

The areas of greatest sediment yield are those of windblown soil in the Palouse River-Walla Walla River areas of Washington and, to a lesser degree, in the Umatilla River basin of Oregon. There is a considerable range in the quantity of fluvial sediment transported; streams draining the more arid lands generally transport more sediment per square mile of drainage area than those draining the humid, forested parts. Sediment concentrations as large as 383,000 mg/l have been measured in streams in the high-sediment yield area of southeastern Washington. Streams originating from glaciers transport a rock material, called "glacial flour," during the summer months, whereas streams that have low flow derived from ground water remain relatively free of fluvial sediment during the summer.

The quality of ground water generally ranges from good to excellent for most uses throughout the region. Water from alluvial deposits and volcanic rocks west of the Cascade Range and in the humid areas east of the Cascade Range usually has less than 300 mg/l dissolved solids. The water ranges from soft to hard, from less than 60 mg/l to more than 120 mg/l. (Hardness of water is expressed in terms of equivalent concentration of calcium carbonate.) Iron is a problem, especially in water from shallow depth in the alluvial deposits. The marine sedimentary rocks yield saline water, at some places at depths ranging from less than 100 feet to several hundred feet.

In the arid and semi-arid areas, the ground water has slightly higher concentrations of dissolved solids than in the humid areas, but still is generally less than 500 mg/l, except in the Oregon Closed Basins where concentrations of 500 to 1,000 mg/l are fairly common. Water from some wells has sodium and fluoride in concentrations high enough to cause problems for irrigation and domestic use. The more highly mineralized water is generally from the deeper wells, or from wells that penetrate older volcanic or sedimentary rocks.

Use and reuse of water for irrigation have resulted in a general down-valley increase in dissolved-solids content of ground water and a deterioration in chemical quality in some heavily irrigated areas. Deterioration of biological and chemical quality of ground-water supplies in and around major population centers has also been noted.

Water Uses

The main consuming uses of water are rural, domestic, municipal, industrial, and agricultural. The principal nonconsuming uses, usually instream, are hydroelectric power, recreation, fish and wildlife, dilution of wastes, quality control, and navigation.

Most of the 7.3 million acres of irrigated land has an adequate supply of water except during the critically dry periods. However, at least 1.7 million acres of land, usually along smaller tributary streams, suffer perennial late-season water shortage. In many areas, an adequate irrigation supply has required the use of all the natural streamflow during the summer, as well as the use of regulatory and hold-over storage. There are almost 200 reservoirs with an individual active storage capacity greater than 5,000 acre-feet and a total active irrigation capacity of 17 million acre-feet. More than 1 million acres of the total irrigated area depend entirely, or in part, upon ground water. The average annual withdrawal of water for irrigation is 5 acre-feet per acre, of which about 1.9 acre-feet per acre is consumed. Some additional water is lost to nonbeneficial consumptive uses. The water not consumed is a return flow contribution or is a recharge to ground water.

Water is reused many times in producing hydroelectric power. It is estimated that 1,300,000 cfs are continually in use for this purpose. During much of the year, most of the flow of the Columbia River is used in power generation. With few exceptions, all of the flow used in power generation is returned, unimpaired in quality, to the rivers.

The annual withdrawal of water for municipal use is estimated to be 1 million acre-feet annually, for industrial use 1-3/4 million acre-feet, and for rural domestic and livestock over 1/4 million acre-feet. The major water demand for these uses is in the area west of the Cascades. The pulp and paper industry is the largest industrial user, amounting to 60 percent of the industrial use.

The production of fish in streams is determined by the quantity and quality of water. The amount of streamflow, especially during the summer low-flow period, is frequently the most important factor limiting their abundance. Regulation of run-off by dams can be important in supplementing flows during the low-flow period, and in protecting the aquatic habitat from damage by floods. On the Willamette River for example, the release of cool, clean water from reservoirs in the headwaters has aided in breaking the pollution barrier during the late summer and fall months in the Portland Harbor area, thus permitting the upstream migration of fall chinook

salmon. The region's anadromous fish resource alone produces an annual commercial harvest of about 45 million pounds of fish. In addition, the resource provides about 5 million angler-days annually.

Water is also essential for wildlife, especially waterfowl; its distribution influences the distribution, and hence the abundance, of all species.

Navigation is generally limited to the coastal areas of Washington and Oregon, the Columbia River below Richland, Washington, the lower Snake and lower Willamette Rivers, and Puget Sound. The deep-water ports on the lower Columbia and Willamette Rivers, Puget Sound, and the coast handle all types of cargo for national and international trade. A slack water channel 14 feet deep exists on the Columbia River to the head of McNary Pool near Richland, and will soon extend up the Snake River to Lewiston, Idaho. The Columbia and Willamette Rivers, several of the larger lakes and reservoirs, and many tidal streams are used in transporting log rafts.

LAND RESOURCES

The Columbia-North Pacific Region has nearly 174 million acres of land area. About 20.8 million acres are presently growing crops, and approximately a third of these are irrigated. There are about 58.8 million acres of land producing forage for livestock and game classified as rangeland. In addition, over 85.8 million acres are classified as forest or woodland, of which a large portion is also grazed by domestic livestock and game animals. More than 8.3 million acres are used primarily for urban development, roads, railroads, industry, and recreation, classified in this report as "Other."

Table 3 - Major Class of the Land Resources
Columbia-North Pacific Region, 1966 1/

Class	Acreage	Percent of Region
Cropland	20.8	12.8%
Rangeland	58.8	33.8%
Forest Land	85.8	49.4%
Other Land	8.3	4.8%

1/ Source: Appendix IV, Land & Minerals

Cropland

The 20.8 million acres of land in the Columbia-North Pacific Region in the category of cropland provide a variety of crops. Although classified under the simple term "cropland," the group includes land from which crops are harvested (small fruits, orchards, vineyards, hops, nurseries), land on which planted crops failed, land previously tilled but left idle in the current year, land in summer fallow, and land in pasture but tilled in regular rotation or in pasture when such use is interchangeable with other crops. The proportion in each of these several conditions varies in different areas.

A regional distribution of major cropping patterns reveals the following features: In the coastal subregion, over two-thirds of the cropland is occupied by forage crops. On the Columbia Plateau, over 40 percent of the cropland is in fallow or practically without vegetative cover. Orchards occupy nearly 10 percent of the cropland in central Washington valleys and in the Willamette Valley in Oregon. They are generally on irrigated lands in central Washington. Nearly half of the row crops, including vegetables, potatoes, sugar beets, and corn, are concentrated on the Snake River Plains in Idaho; another large area of similar crops is the Columbia Basin project in central Washington. Small grain crops occupy from a third to half the cropland, except along the western coastal edge. Grain is grown on summer fallowed land in the dry central plateau areas, and as an annual crop in most of the other areas.

Some of the lands have been cropped for a hundred years or more. The better lands of the Palouse, Columbia Plateau, Willamette Valley, and the Snake River Plain have been farmed for over 75 years. In comparison, many of the smaller farms on land cleared out of cutover forest areas have been developed in relatively recent years with the closing of the timber harvesting industry and the concentration of suburban population around the metropolitan centers. Trial and failure of poorly adapted crops, erosion caused by excessive or untimely tillage, and the resulting farm abandonment have helped to sort the better cropland from the poorer areas. Some of the cropland is operated by only the second or third generation of farmers, and handling of the cultivated lands shows the basin is still in a pioneering era.

Irrigation development of the croplands has progressed through three broad stages: (1) stream diversion to adjacent river flood plains and through furrows onto the fields; (2) the development of storage reservoirs and diversion to the higher benches and terraces; and (3) then the development of sprinkler irrigation systems, using stream, reservoir, and well water supplies.

Most of the croplands on the plateau east of the Cascades have developed on soils originally occupied by a grass or

grass-brush type cover. These soils are fertile and produce excellent yields of grain.

Rangeland

Rangeland comprises 58.8 million acres, or slightly less than 34 percent of the total regional area. These lands provide 7.3 million animal unit months (AUM's) of livestock grazing. Public land contributes a little more than 4.3 million AUM's and private rangeland accounts for 3.0 million AUM's. This land cover type may be separated into three general kinds of range which are influenced by climate, soils, and elevation.

The areas at the higher elevations are characterized by open grassland in which bunchgrasses are dominant, and perennial forbs and shrubs are common. These areas occur primarily on side slopes and ridgetops. Groups of trees are interspersed in the ravines and on the northern exposures. Meadow-type grasses and forbs and grass-like plants are prevalent in areas adjacent to streams and in mountain meadows. Shrubs are rare. This kind of range provides important summer forage for sheep and cattle, and for elk and deer for a longer season. Poisonous plants are not a great problem in the higher elevational zones.

Where the stand of desirable vegetation has been reduced due to past heavy grazing, fire, and other severe treatments, the water absorption ability of the soil is diminished.

Open range occurs at intermediate elevations just below the lower fringes of the timbered areas. It is intermingled with or surrounded by the heavier timber type in northern Idaho, western Montana, and at lower elevations in western Oregon and Washington. These grasslands are more extensive than those on the higher

Typical rangeland cover in the arid portion of the region. (Oregon State Highway Department)

elevation range. The forage is of a type that will tolerate drier conditions, originally consisting largely of perennial bunchgrasses and perennial forbs. Meadows are quite prevalent along the creeks and rivers. This kind of range furnishes spring, early summer, and fall forage for livestock and provides important spring-fall, and sometimes winter, forage for deer and elk.

The more gently sloping range at lower elevations is characterized by bunchgrasses, sagebrush, shrubs, and perennial forbs. Included are plateaus, river bottoms, flats and benches, generally with wind deposited or glacial wash soils over basalt bedrock.

On all the range there are areas where the original desirable vegetation has been replaced largely by undesirable vegetation due to long periods of excessive use--both game and livestock, wild and man caused fires, drouths, and other abusive uses. Noxious and poisonous plants such as goatweed, halogeton, larkspur, and Medusahead wildrye are quite prevalent in certain localities.

About 19 percent of the rangeland is in good condition; 44 percent is in fair condition; and about 37 percent is in poor condition. In addition to unfavorable forage production, poor condition range frequently has unstable soils with excessive erosion and runoff.

Forest Land

Of the total regional area, 49.4 percent or 85.8 million acres are classified as forest land. The forest cover types can be geographically divided into three parts; (1) the Douglas-fir area west of the Cascade Range; (2) the pine area surrounding the Columbia Plateau; and (3) the western part of the Rocky Mountain area.

The Douglas-fir region is located in western Oregon and western Washington where the moist climate favors the growth of large trees and dense timber stands. Principal species found here are the Douglas-fir, western hemlock, western red cedar, Sitka spruce, Pacific silver fir and noble fir. Douglas-fir is the predominant species except in areas such as the humid slopes of the Coast Range where western hemlock and Sitka spruce are important. In the upper slopes of both the Coast and Cascade Ranges, the stands are composed of true firs, western hemlock, mountain hemlock, and lodgepole pine.

On the drier exposures of the interior valleys and foothills of southern Oregon, Douglas-fir is still the principal species in the stand. The associated species change considerably, however, as species from northern California extend into the association. These include the hardwoods, chiefly the oaks, red alder, Pacific madrone, and big leaf maple, and the conifirs including the

Forest and water - important resources of the region. (U.S. Forest Service)

spruce-fir, western hemlock, sugar, ponderosa, western white pine, and the redwood type.

In the Coast and Cascade Ranges of Oregon and Washington, the virgin Douglas-fir forests are broken by extensive even-aged second-growth forests, varying in age from 60 to 100 years. These are the result of large fires that burned during the middle and late 19th century. Scattered throughout the area are a number of fairly recent burns, occurring after the turn of the century. Some include the Yacolt in southwest Washington and the Tillamook in northwest Oregon, where 385,000 acres were burned over in a short period. Although these areas reburned repeatedly, resulting in some serious erosion and soil loss, more intensive fire protection and major public and private reforestation efforts have almost completely rehabilitated these lands. Except for isolated spots, both burns are well-stocked with coniferous species.

The ponderosa pine region occurs east of the Cascade Range in Washington and Oregon. Here, the climate is much drier than in the Douglas-fir region. There are two timberlines which limit the extent of the forest land area on the east side. As on the west side, there is an upper timberline associated with the severe climatic conditions at high elevations which does not allow forest tree species to survive. The other or lower timberline is associated with arid conditions, and it can be referred to as the grass shrub timberline. The Cascade Range is an effective barrier to the moisture-laden westerly winds blowing in from the Pacific Ocean. As a result, extensive areas of eastern Washington and eastern Oregon have very low precipitation levels in the lower elevations. Thus, the grass shrub timberline occurs at the elevations below which forests are adapted due to the lack of moisture. The timber

zone then lies between the two timberlines, and is generally confined to the more mountainous areas which have sufficient moisture supplies and suitable climate to sustain forest growth.

This area is generally characterized by vast, pure stands of ponderosa pine which occur at low elevations just above the grass shrub timberline. At higher elevations, the pure pine stands give way to mixed stands of Douglas-fir, western larch, white fir, and lodgepole pine. In colder areas and moist areas at high elevations noble fir, Engelmann spruce, alpine fir, western hemlock, and white pine are found.

The western part of the Northern Rocky Mountain Region is located in north and central Idaho and Montana west of the Continental Divide. Douglas-fir is the predominant species, with lodgepole pine a close second. The true firs, western white pine, larch, and ponderosa pine are also important species, of which the latter two are found principally in northern Idaho and western Montana. Western red cedar, western hemlock, and Engelmann spruce are lesser constituents.

This interior country has also been subjected to extensive forest fires, occurring from the turn of the century through the present time. Although very detrimental to the cover at the time of burning, reforestation, early grass seeding, and brush growth restored these watersheds quite effectively.

Generally speaking, the forest lands of the Columbia-North Pacific Region are in reasonably good condition. Thirty-three percent of all ownerships have a high level of stocking of desirable tree species; 34 percent have a medium level, while 30 percent are poorly stocked. Only 3 percent are nonstocked. Within the poorly stocked stands, 40 percent are publicly owned and 60 percent are privately owned. Although considerable portions of the understocked areas need further improvement, present inventories support current levels of timber harvesting.

About 28.9 million acres of regional forest lands were grazed by domestic livestock or had potential for forage production. These areas have an estimated grazing capacity of 2.5 million animal unit months (AUM's), 58 percent from public forest land and 42 percent from private land. In terms of forage production, 32 percent of the forest range is in good condition, 36 percent in fair condition, and 32 percent in poor condition.

Other Land

Certain lands do not fit any of the cover classes discussed so far. Included are such diverse kinds of land as rock, sand dunes, ice fields, urban and industrial areas, roads, airports,

Other land uses (urban and industrial) on the flood plain of the Columbia River. (FWPCA)

cemeteries, bodies of water under 40 acres and streams less than 1/8 mile in width. This miscellaneous land class aggregates over 8.3 million acres within the region, comprising about 5 percent of the net land area.

There is also a significant area of water surface which includes lakes and meandered streams.[1/] It amounts to almost 1.9 million acres, in addition to the net land area of the region. Although small in size, the water areas play an extremely important part in the economy and development of the land. They are the

1/ Water areas include: water bodies over 40 acres and streams over 1/8 mile wide.

Table 4 - Major Type of Other Lands
Columbia-North Pacific Region, 1966 [1/]

Use or Cover	1,000 Acreage	Percent
Barren	5,016.8	60.3
Domestic [2/]	1,987.2	23.9
Roads & Railroads	869.5	10.4
Water [3/]	449.9	5.4
TOTAL	8,323.4	100

1/ Source: Appendix VIII, Land Measures & Watershed Protection
2/ Includes: urban, industrial, airports, golf courses, farmsteads and misc.
3/ Water bodies less than 40 acres and streams less than 1/8 mile wide

habitat of the fisheries resource, serve transportation, and are closely related to the distribution of recreation areas and activities.

Besides the water and associated land problems common to other land, water originating on these lands often flows on to adjacent cropland, rangeland, and forest land causing serious problems. The situation is most acute in urban and industrial areas where runoff approaches 100 percent.

MINERAL RESOURCES

While the Columbia-North Pacific Region is not one of great mineral wealth when compared to the Nation, its mineral resources play an important role in its economy, and provide a vital source of raw materials for its industry. The mineral resources are generally classified as metals, nonmetals, and mineral fuels.

Metals

The two outstanding metal-producing areas are the Coeur d'Alene area in Shoshone County, Idaho, and the Butte area in Silver Bow County, Montana. The metal production from these areas, principally copper, silver, gold, lead, and zinc, had exceeded $6 billion in value. A third major productive area is northeastern Washington in Pend Oreille and Stevens Counties. There are, in addition, many other smaller productive or potentially productive areas scattered throughout the region.

Montana has furnished about 15.3 percent of the total national production of copper; about 99 percent or more of this production has come from the Butte area. In 1965, Silver Bow County (the Butte area) produced copper, lead, zinc, gold, and silver with a total value of $97,373,000. Despite more than 80 years of continuous production, recent discoveries of additional reserves have materially increased the known deposits so that, currently, reserves are at an alltime high. Butte will be able to produce copper at the present annual rate of 100,000 tons or more for many years. Other mining districts in western Montana have produced substantial amounts of metals, especially placer gold, but the total tonnage values are not comparable to the Butte area. Most of the bonanza deposits that were highly productive in the late 1800's and early 1900's are depleted and have produced only minor amounts of metals in recent years. An exception is the Phillipsburg area where there has been substantial manganese production. The Heddleston district, north of Butte, once productive but inactive for many years, is being revived and is expected to become

Copper mining and processing in Montana. (US Bureau of Mines)

a major producer of copper.

Idaho is a major producer of silver, lead, and zinc. In recent years, it has ranked first in the Nation in the production of silver, second in output of lead, and second or third in output of zinc. The principal metal output is from the Coeur d'Alene area of Shoshone County in northern Idaho. Production of gold, silver, zinc, copper, and lead from 1884 to 1965 was valued at $2.09 billion. The 1965 production had a total value of $62,054,000. A very much smaller output of silver, lead, and zinc currently comes from Bonner, Blaine, Butte, Custer, Gem, Lemhi, and Owyhee Counties.

Estimates of silver-lead-zinc ore reserves in Idaho indicate a minimum of 10 years of production at the current annual rate. Exploration is active and there are likely potential reserves for many more years. About 90 to 98 percent of the estimated reserves are in the Coeur d'Alene area. Idaho mines have been a leading source of tungsten, antimony, mercury, cobalt, columbium-tantalum, and rare earth metals, and are currently producing mercury and antimony. Potential reserves of these metals are adequate for several years of future production (if the market price meets the costs of production).

Washington mines have been an important source of silver, lead, and zinc, principally from the northeastern corner of the State in Stevens and Pend Oreille Counties. The State also has one of the few gold mines still operating in the Nation, near Republic in Ferry County, and is also the only State in the region

with an important uranium producing area, located near Spokane.

In the period from 1860 to 1963, Washington production of gold, silver, copper, lead, and zinc was valued at $325,104,000. In the period from 1906 to 1965, the Metaline district, in northern Pend Oreille County, produced silver, gold, copper, lead, and zinc, valued at $133,086,000. The Metaline district is important because of the large potential resources of low-grade ores of lead and zinc. There are known reserves equal to 40 years of production at the current annual rate and estimated reserves equal to more than 100 years production.

The Railroad Creek district (Holden mine) in Chelan County was an important producer of copper and gold before the mine was closed in 1957. The district produced more copper than all other copper districts in Washington combined, and was the second largest gold producer in the State. A nearby copper area on Miners Ridge (Glacier Peak) has been extensively explored, but only 50,000 short tons of copper are indicated. No production has come from this deposit.

The Republic-Danville-Curlew district near Republic in Ferry County has been the largest gold producer in Washington State. Reserves appear to be sufficient for several years at the present annual rate of production.

The uranium deposits are in two closely associated areas a few miles north of the City of Spokane. Shortly after discovery in 1954, a mill was built at Ford, Stevens County; it operated from 1957 until 1965. Total uranium oxide production to 1965 was 4,700,000 pounds. Most of the production was from the Midnight mine, which ceased operation in 1965 when its contract with the Government had been completed. A substantial tonnage of ore is available for mining. Recently, additional discoveries have been announced south of the mine, and resumption of mining and milling in the area is likely.

Oregon holds the distinction of being the only State in the Nation producing nickel. The ore comes from Nickel Mountain, near Riddle, Douglas County. Mining started at this deposit in 1954. Annual production recently has been 12,000 to 14,000 tons of nickel. Estimates indicate reserves are sufficient for 10 to 15 years output at the present rate of production. Oregon has been a major producer of mercury in the past; production from 1882 to 1961 was approximately 103,000 flasks (1 flask equals 76 pounds). Most of the production has come from the Horse Heaven mine, Jefferson County; Black Butte mine, Lane County; Bonanza mine, Douglas County; and the Bretz and Opalite mines in Malheur County. Production in 1965 was 1,364 flasks. The Bretz and Black Butte mines accounted for nearly all of this output. Oregon has been a

fairly substantial producer of gold and silver; copper, lead, and zinc production has been relatively small. Only a few thousand tons of copper and a few hundred tons of lead and zinc have been produced. A small amount of gold and silver came from Grant, Jefferson, Josephine, and Malheur Counties in 1965.

NONMETALS

The largest amounts of nonmetals produced, both in tonnage and value, are those used for construction and building materials or products. These include sand and gravel, stone, and clay. These minerals and mineral materials are of low unit value and must be produced from deposits near the market. Phosphate rock production is also of major economic importance. Of less importance is production of vermiculite, fluorspar, barite, garnet, magnesite, olivine, and pumice and volcanic cinders.

Sand and gravel is a ubiquitous material in the region; only deposits near urban markets or convenient to construction projects are generally developed or considered of economic value. Some problems arise locally due to the increasing competition of other land uses, particularly in and near urban centers and due to the effects on fish populations. The total supply of sand and gravel is virtually inexhaustible. Production of sand, gravel, and crushed stone in 1965 totaled about 103 million tons.

Dimension and crushed stone are the principal stone products. Dimension stone is used for buildings, fireplaces, and other construction; its production is of minor economic importance as the market is small and irregular. Crushed stone is produced in large quantities from many varieties of raw material such as limestone, basalt, ultramafic and granitic intrusive rocks, sandstone, quartzite, and other sedimentary and metamorphic rocks. Principal uses of crushed stone are for concrete aggregate, road surfacing, and railroad ballast. Most of the roadstone is produced from small roadside quarries used intermittently when there is local need for the material. Numerous stone quarries are situated near urban centers where there is a large and continuous need for aggregate. Reserves of stone suitable for crushing are virtually inexhaustible, although there may be local areas where quarry sites are unavailable or difficult to acquire due to competing land uses.

Limestone has many uses in addition to that of aggregates or roadstone, depending on the purity of the deposit. It is found in many areas and in many grades of purity, and is quarried in Montana for metallurgical use and manufacture of lime. In Idaho, it is quarried for cement, lime, pulp and paper manufacture, sugar refining, metallurgical, agricultural use, terrazzo, and roofing chips. The reserves of limestone are very large, and will not be

exhausted by the foreseeable future demand.

The use of clay, which occurs widely over the region, is largely determined by its physical and mineralogical character. Common clays are the most widely distributed and are mined in numerous places (generally near urban centers or areas of denser population and industry), for manufacture of common brick and tile. The higher grade refractory-type clays and high alumina clays are much more valuable and are found in more limited areas. These clays are found in Latah County, northern Idaho (where a plant at Troy produces firebrick and refractories, and a plant at Bovill produces paper-filler grade clay); near Spokane; and near Seattle, where intermediate to high heat duty refractories are produced. Deposits of refractory grade clays are also located in Cowlitz and Lewis Counties, Washington, and in Marion, Washington, and Lane Counties, Oregon, but very little production has come from these areas in the past. Enormous reserves of high alumina and refractory-type clays are available, and the future production will be largely based on markets for the products.

Phosphate rock production is of major importance to the economy of Montana and Idaho. It is used in manufacture of phosphate fertilizers, elemental phosphorous, and some minor products. Phosphate rock is mined north of Garrison in Powell County, Montana. A plant produces elemental phosphorous in Silver Bow County from raw material from outside the region. Reserves in Montana are estimated at more than 200 million tons. Bingham, Caribou, and Bannock Counties in southeastern Idaho are the center of western phosphate resources and production. Fertilizer and elemental phosphorous plants are located at Pocatello and Soda Springs. Output of phosphate rock in 1965 was 3,700,000 long tons. Reserves are estimated as several billions of tons, enough for many years at current production.

Production of vermiculite concentrates exceeds 100,000 tons per year, and this operation is the principal source of the material in the United States. Resources are extensive and the outlook for an increase in future production is favorable.

Fluorspar comes from deposits near Darby, Montana. The mines have been producing since 1952, and reserves are sufficient for several more years at the present rate.

Barite was produced near Greenough, Montana. Production is limited by available markets.

Garnet comes from placer deposits in Benewah County, Idaho, and from stockpiled material at Lowman, Idaho. Production is limited mainly by sales to available markets. Resources are adequate for many years of future production.

Magnesite was produced north of Spokane, Washington, in Stevens County. Since World War II, Washington, Nevada, and California have supplied all the United States production and, for several years, Washington was the largest producer. Magnesite was shipped to the eastern states where it was made into refractory brick for use in the steel industry.

The olivine production comes from Skagit and Whatcom Counties, Washington. This is one of the largest deposits known in the Nation. Reserves are adequate for years at the current production rate.

MINERAL FUELS

Most of the coal reserves in the region are in western Washington. A total of about 150,000,000 tons of coal has been produced in the State. In 1965, production was about 55,000 tons. The remaining coal reserves in Washington are estimated to be 6.2 billion tons. Interest in coal has been revived recently with plans for coal-fired thermal-electric plants to supplement the present hydro-electric generating capacity. Most of the coal reserves are in King, Kittitas, Pierce, Lewis and Cowlitz Counties, Washington. Oregon contains some formerly productive coal fields in the Coos Bay area, but there has been very little activity in recent years.

No producing oil or gas fields are present in the Columbia-North Pacific Region. There has been considerable exploratory drilling, and some gas has been found. Also, a few oil shows have been discovered but, to date, they have not been brought into production.

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COLUMBIA-NORTH PACIFIC REGION COMPREHENSIVE FRAMEWORK STUDY OF --ETC(U)
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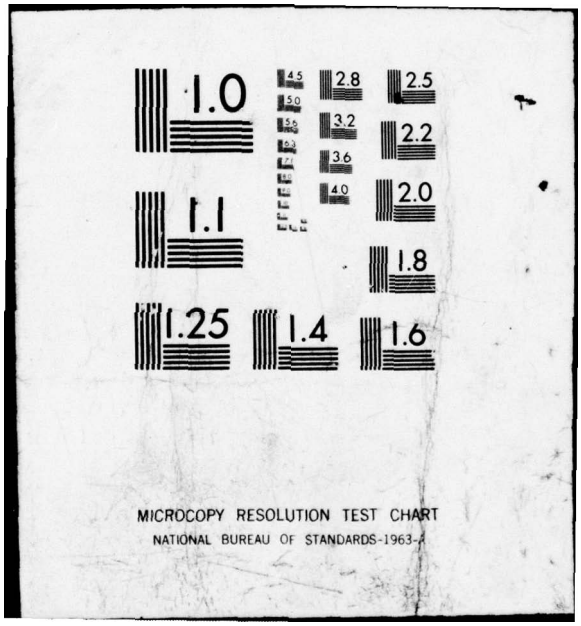
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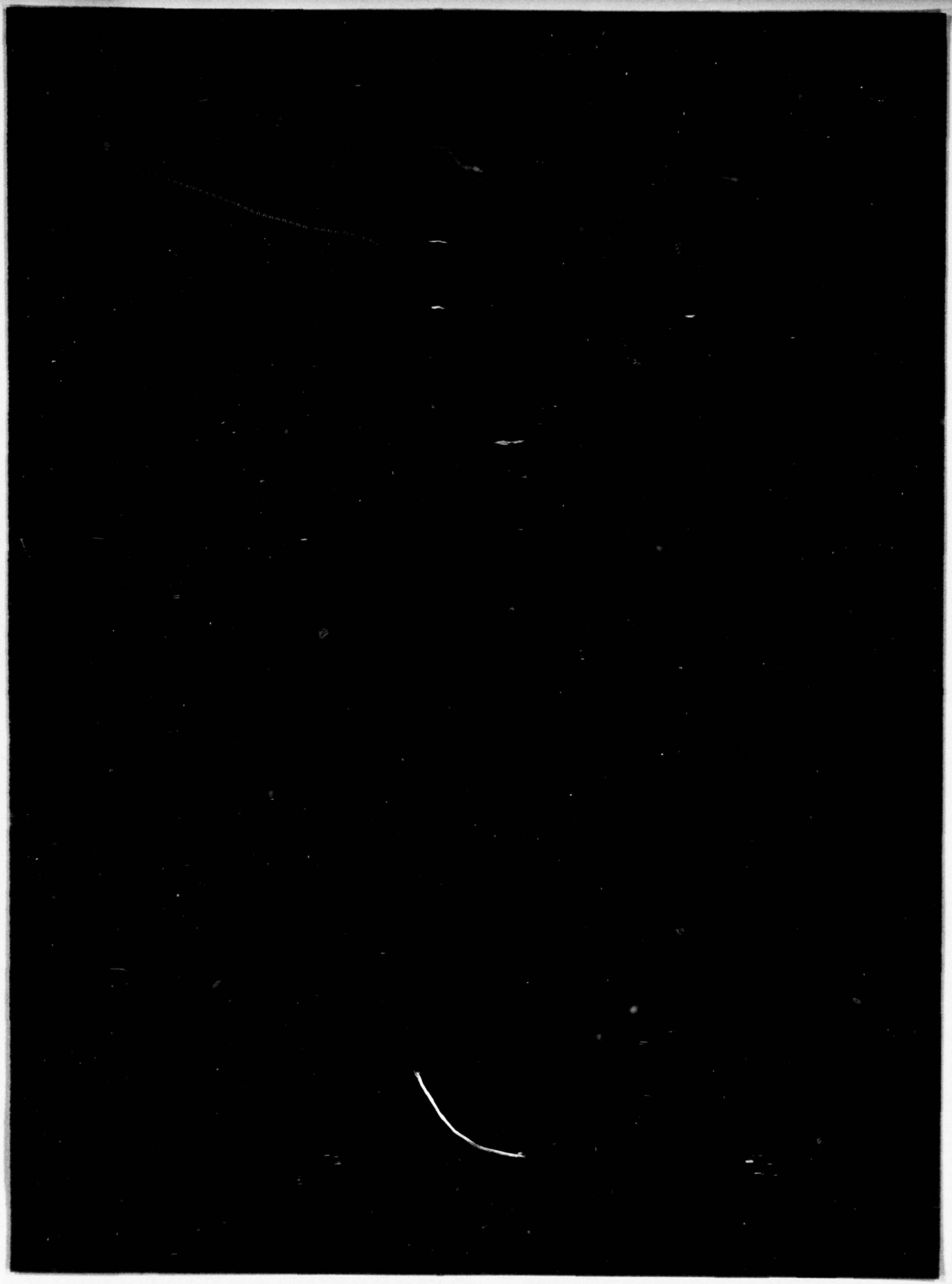


POPULATION CHARACTERISTICS

GROWTH

Since the time of early settlement, and typical of most of the West, population growth of the Columbia-North Pacific Region has been more rapid than that of the Nation as a whole. By 1960, the population was 5.4 million, an increase of more than 56 percent over the 1940 population. By 1965 the estimated population had reached 5.9 million. The principal period of growth was during the war years between 1940 and 1950, when the regional growth rate was 33 percent as compared to the national growth rate of 14 percent. During the next decade the regional growth rate slowed to 18 percent, as compared to the national rate of 19 percent making an average ratio of 25 percent per decade over the 20-year period. These relationships are illustrated in figure 12.

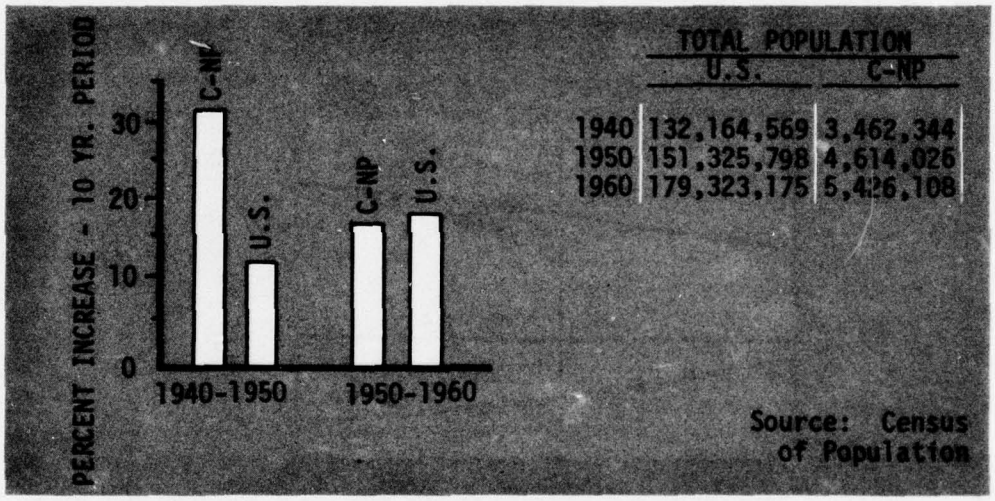


FIGURE 12. Comparison of Growth Trends of the Columbia-North Pacific Region and the United States.

Between 1950 and 1960 Subregions 2 and 11 experienced larger percentage increases than the national average. The increase in Subregion 11, Puget Sound, is typical of the population trends for such industrial centers. A major impetus to this rapid growth was the development of Boeing, one of the world's largest manufacturers of commercial jet aircraft. Not only has Boeing grown rapidly but its growth has created a large market for smaller manufacturing of a myriad of aircraft components.

Subregion 2, Upper Columbia, is primarily a rural area containing relatively small agricultural communities. Contrary to the national trend, ubregion 2 experienced a 23 percent increase in population between 1950 and 1960, due primarily to growth in nearly developed irrigated areas. That part of the subregion within the Columbia Basin Irrigation Development project experienced a 114 percent increase. (8-35)

DISTRIBUTION

The distribution of population within the region by urban, rural, and rural non-farm classifications has closely followed the national pattern. The trend has generally been an increase in urban, a decrease in rural farm, and an increase in rural non-farm population.

As percentages of the total population, the trends have been similar except for rural non-farm, which has remained relatively stable in the region. Comparisons of these trends are illustrated in figure 13. Detailed data on population characteristics are contained in table 5.

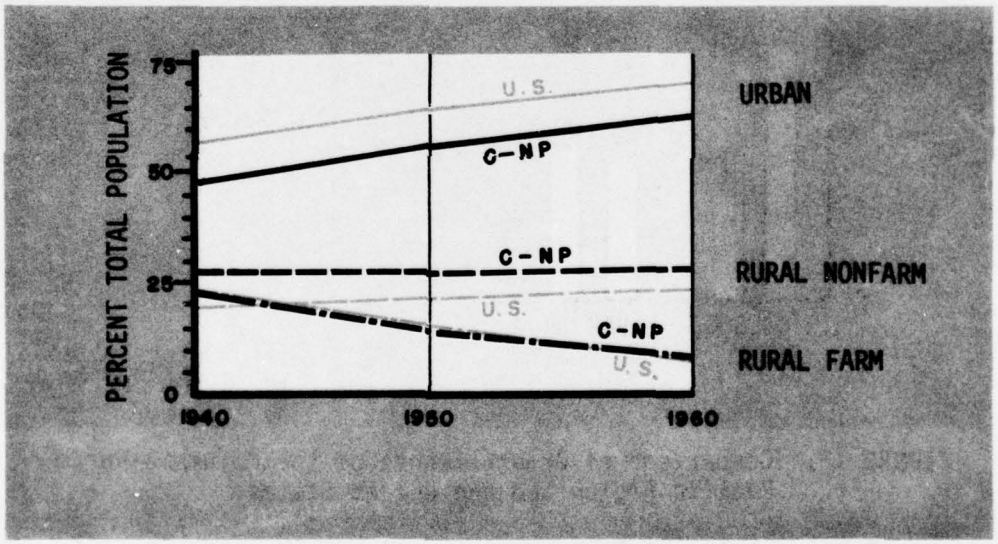


FIGURE 13. Comparisons of the Distribution of Population in the Columbia-North Pacific Region and the United States

URBANIZATION

In 1940, about 44 percent of the region's population lived in metropolitan areas designated by the Bureau of the Census

Table 5 - Population Characteristics of the Columbia-North Pacific Region for Census Years 1940, 1950, and 1960 1/

Item	United States	Columbia-No.Pacific	POPULATION SUBREGIONS 1	2	3	4	5	6	7	8	9	10	11	12
1940 Total	132,164,569 2/	3,462,344	417,414	130,130	131,302	217,772	178,305	137,338	143,194	161,290	691,204	235,612	1,007,116	11,667
Urban	74,694,414	1,684,723	225,139	22,110	36,848	72,137	68,632	34,695	49,549	58,930	403,387	89,593	621,137	2,566
% of Total	57	49	54	17	28	33	38	25	35	36	58	38	62	22
Rural Farm	30,318,552	812,736	81,140	50,557	46,666	92,049	66,983	51,733	47,751	51,113	130,522	57,679	133,114	3,429
% of Total	23	23	19	39	36	42	38	38	33	32	19	24	13	29
Rural Nonfarm	27,120,169	964,885	111,135	57,463	47,788	53,586	42,690	50,910	45,894	51,247	157,295	88,340	252,865	5,672
% of Total	20	28	27	44	36	25	24	37	32	32	23	38	25	49
1950 Total	151,325,798 3/	4,614,026	489,391	157,388	209,328	242,522	215,258	148,850	184,891	214,021	992,387	328,806	1,418,422	12,762
% Change from 1940	14	33	17	21	59	11	21	8	29	33	44	40	41	9
Urban	96,847,000	2,631,877	299,385	45,429	109,873	99,285	102,503	62,595	74,808	93,768	633,202	115,424	989,681	5,924
% of Total	64	57	61	29	52	41	47	42	41	44	64	35	70	46
Rural Farm	23,048,350	682,569	56,108	42,927	43,906	77,964	61,717	37,147	40,947	43,643	116,548	50,084	108,433	3,145
% of Total	15	15	12	27	21	32	29	25	22	20	12	15	8	25
Rural Nonfarm	31,431,000	1,299,580	133,898	69,032	55,549	65,273	51,038	49,108	69,136	76,610	242,637	163,298	320,308	3,693
% of Total	21	28	27	44	27	27	24	33	37	36	24	50	22	29
1960 Total	179,323,175 3/	5,426,108	563,748	193,594	227,649	277,249	252,430	155,991	198,665	224,480	1,168,899	381,384	1,768,117	13,902
% Change from 1950	19	18	15	23	9	14	17	5	7	5	18	16	25	9
Urban	125,283,783	3,429,657	362,318	68,319	123,430	132,169	131,993	74,031	89,651	105,829	858,620	152,394	1,324,120	6,783
% of Total	70	63	65	35	54	48	52	48	45	47	73	40	75	49
Rural Farm	13,444,898	443,320	36,319	35,732	32,602	69,455	47,869	26,615	28,513	20,054	68,982	27,164	47,860	2,155
% of Total	7	8	6	18	14	25	19	17	14	9	6	7	3	16
Rural Nonfarm	40,596,990	1,553,131	165,111	89,543	71,617	75,625	72,568	55,345	80,501	98,597	241,297	201,826	396,137	4,964
% of Total	23	29	29	47	32	27	29	35	41	44	21	53	22	35

1/ Source: Census of Population
2/ Source: Tables 10 and 873 1965 Statistical Abstract
3/ Source: Table 11 1965 Statistical Abstract

as "Standard Metropolitan Statistical Areas" (SMSA). By 1960, the proportion of the population living within SMSA's had increased to nearly 50 percent. A comparison of rates of growth shows the SMSA's to be growing considerably faster than the remainder of the region.

As noted above, the region experienced a 33 percent increase in population between 1940 and 1950. A breakdown shows the SMSA's had an increase of nearly 44 percent for the same period while the increase in the remainder was about 25 percent. These relative positions held through the following decade. Table 6 illustrates these relationships.

Table 6 - Population of Selected Standard Metropolitan Statistical Areas in the Columbia-North Pacific Region - 1940, 1950, and 1960 1/

Area	Population				
	1940	% Change From 1940	1950	% Change From 1950	1960
Columbia-North Pacific, Total	3,462,344	33.3	4,614,026	17.6	5,426,108
Columbia-North Pacific, Excluding SMSA's	1,951,506	25.1	2,441,412	12.0	2,734,185
SMSA's 2/					
Eugene 3/	69,096	82.1	125,776	29.5	162,890
Portland	501,275	40.6	704,829	16.6	821,897
Seattle 4/	593,734	42.2	844,572	31.1	1,107,213
Spokane	182,081	51.5	275,876	16.6	278,333
Tacoma	164,652	34.6	221,561	25.6	321,590
Subtotal, SMSA's	1,510,838	43.8	2,172,614	23.9	2,691,923
Percent of Total C-NP	*43.6*	--	*47.1*	--	49.6 5/

1/ Source: Census of Population.
2/ SMSA boundaries for 1940 were adjusted to correspond with the county boundaries delineating the 1950 and 1960 SMSA's.
3/ Eugene was not classified as an SMSA in 1940, but the area figures are included here for comparison.
4/ Became Seattle-Everett SMSA in 1959.
5/ This percentage does not reflect the fact that Boise, Idaho, SMSA was created in 1963, and Salem, Oregon, in 1964.

EMPLOYMENT

Employment increased from 1.19 million in 1940 to 1.73 million in 1950, and to 1.98 million in 1960. The employment population ratio has remained stable at slightly over one-third of the population. The regional employment level followed a pattern very close to that of the Nation during this period. Figure 14 compares these employment levels. The stability exhibited in the general level of employment has not been present in some industries.

Manufacturing has shown a large increase in employment from about 230,000 in 1940 to about 447,000 in 1960. Retail

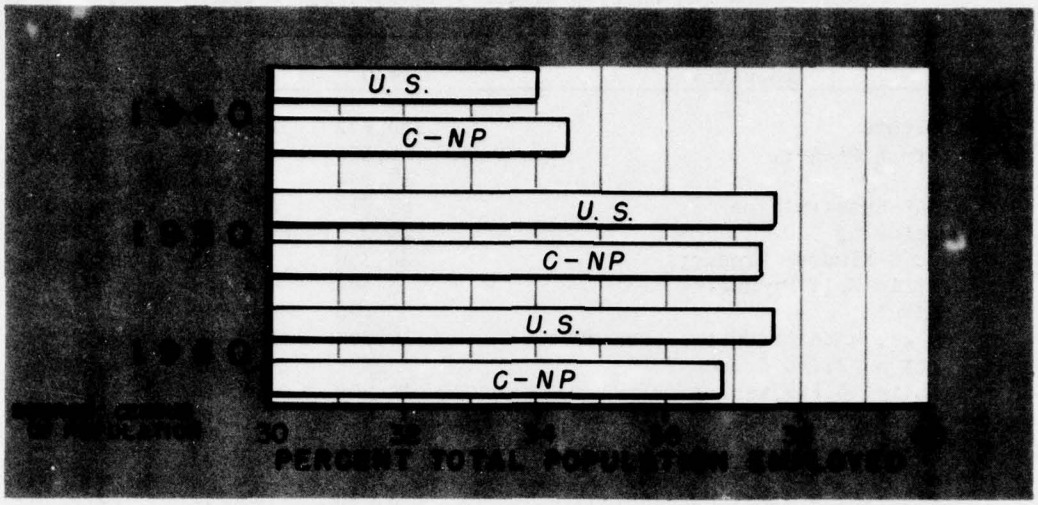


FIGURE 14. A Comparison of the Employment Levels of the Columbia-North Pacific Region and the United States.

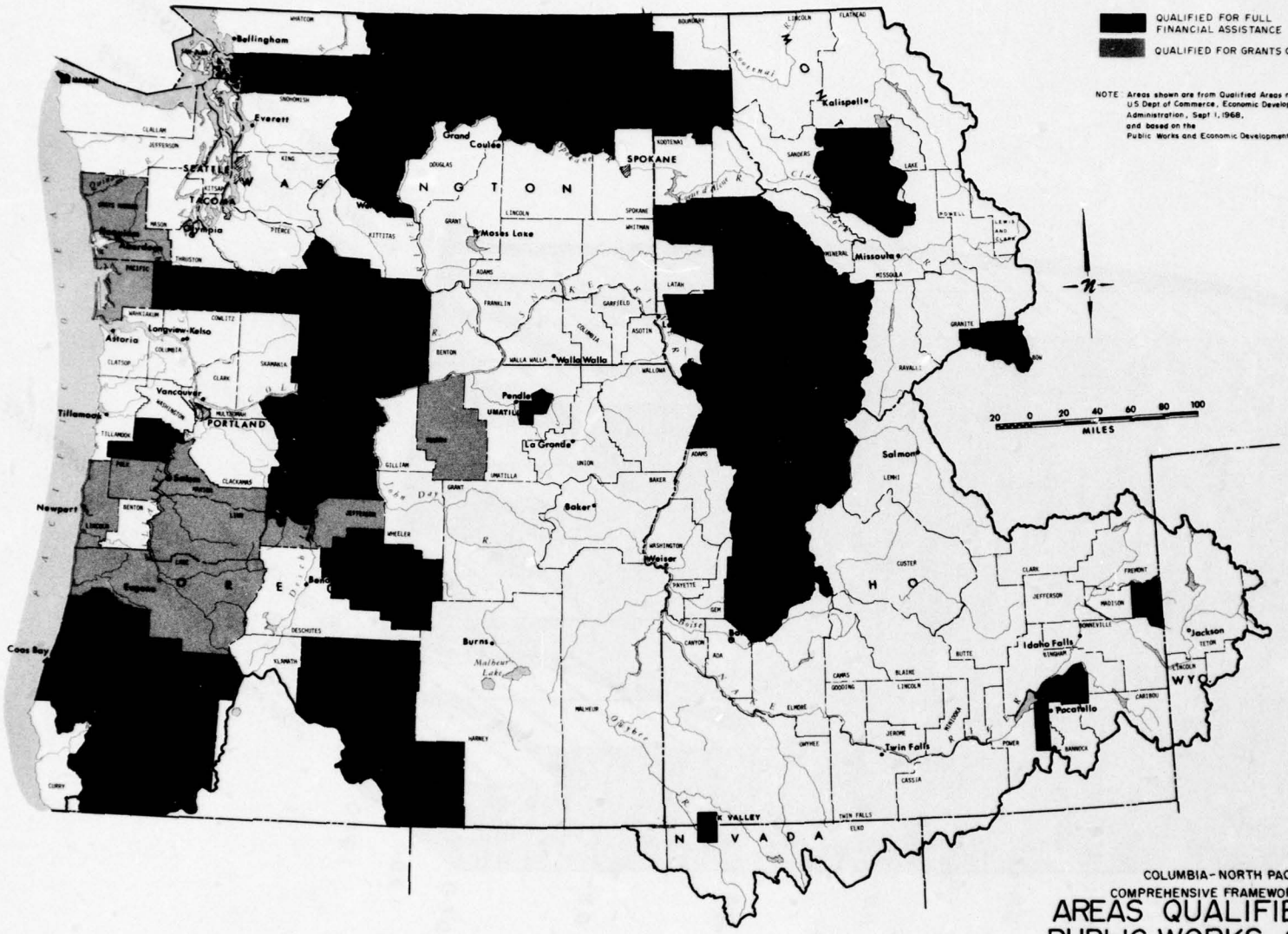
trade has increased from nearly 184,000 in 1940 to 309,000 in 1960. Professional services have more than doubled during this period. Agriculture, on the other hand, has decreased from about 221,000 in 1940 to 156,000 in 1960, with most of the decrease taking place between 1950 and 1960. The decrease in agricultural employment has been caused in part by increased mechanization and improved farming methods resulting in less demand for farm labor. Table 7 presents detailed employment statistics for the Columbia-North Pacific Region. Figure 14 and table 8 illustrate employment trends for some selected major industries.

Unemployment and underemployment levels differ greatly from one part of the region to another. Generally, at least in recent years, those areas dependent on basic natural resources have been troubled the most. Figure 15 shows the areas that qualified for grants under the Public Works & Economic Development Act of 1965, and, as such, are areas where unemployment and underemployment are generally a serious problem. Qualification for grants is based on two major criteria: "(a) The severity and duration of unemployment as indicated by the average annual unemployment in the last calendar year (1967), and, in a few cases, the average annual unemployment over the last four years; (b) Median family income levels." (5-ii) While this map doesn't indicate specific levels of unemployment or underemployment, it does show general areas where these economic problems are significant.

Table 7 - Employment by Selected Industries [1/]
Columbia-North Pacific Region - 1940, 1950, & 1960

Industry	1940	1950	1960
Agriculture	220,872	210,478	155,767
Forestry & Fishery	8,326	11,876	11,672
Mining	24,044	17,694	11,418
Contract Construction	67,915	132,391	129,460
Manufacturing	(229,995)	(338,900)	(447,025)
Food & Kindred Products	30,380	40,621	58,903
Textile Mill Products	3,193	4,108	3,944
Apparel	3,896	4,746	7,347
Lumber, Wood Products, Furniture	115,291	153,180	143,012
Paper & Allied Products	2/	18,858	26,171
Printing & Publishing	14,961	20,915	27,320
Chemicals & Allied Products	2,822	11,210	16,334
Petroleum	2/	1,728	2,824
Primary Metals	2/	18,169	19,942
Electrical & Other Machinery	5,946	11,512	25,383
Motor Vehicles & Equipment	1,337	2,110	4,223
Other Transportation Equipment	15,055	29,311	77,267
Other & Miscellaneous	37,114	22,437	34,355
Service & Distributive Industry	(221,518)	(317,694)	(436,368)
Railroads & Railway Express	33,474	46,969	35,786
Trucking & Warehousing	15,578	23,938	29,610
Other Transportation	20,899	32,286	32,758
Communications	11,282	23,713	26,460
Utilities & Sanitary Service	15,993	26,460	28,957
Wholesale Trade	41,133	65,243	82,813
Retail Trade	149,385	218,632	245,868
Eating & Drinking Places	34,454	60,826	63,498
Finance, Insurance & Real Estate	37,085	58,132	79,937
Hotels & Other Personal Services	49,175	59,540	59,986
Private Households	38,166	33,874	52,527
Business & Repair Services	27,596	45,943	49,185
Entertainment & Recreation Services	11,422	16,090	14,982
Medical & Other Professional Services	95,159	162,247	259,688
Public Administration	44,271	81,106	98,861
Armed Forces	15,873	61,029	62,498
TOTAL	1,192,097	1,727,372	1,978,756

1/ Source: Census of Population.
2/ Not separately identified; included in Other & Miscellaneous.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

AREAS QUALIFIED FOR PUBLIC WORKS GRANTS

THE REGION

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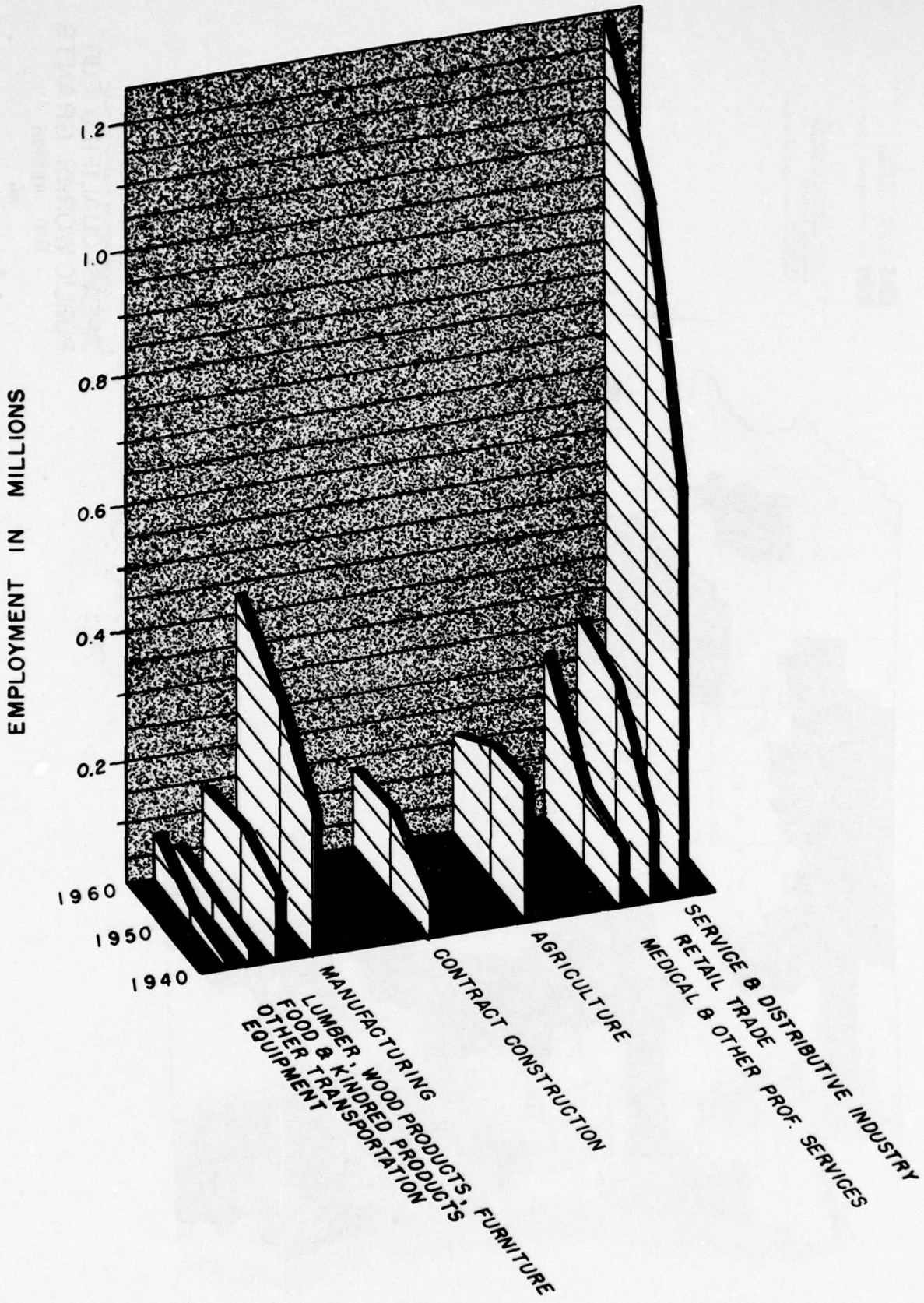
FIGURE 15



88 FIGURE 16. Past Employment Trends for Selected Major Industries

Table 8 - Percentage Distribution of Employment by Economic Sector
Columbia-North Pacific Region - 1950 & 1960 1/

Industry	Employment		Percent Change	Percentage Distribution 2/	
	1950	1960	1950-1960	1950	1960
Agriculture, Forestry, Fishing	222,354	167,439	-24.7	12.87	8.46
Mining	17,694	11,418	-35.5	1.02	0.58
Construction	132,391	129,460	- 2.2	7.66	6.54
Manufacturing	338,905	447,025	24.2	19.62	22.59
Transportation	103,193	98,154	-.5	5.97	4.96
Communication and Utilities	50,173	55,417	0.9	2.90	2.80
Wholesale Trade	65,243	82,813	21.2	3.78	4.19
Retail Trade	279,458	309,366	9.7	16.18	15.63
Finance, Insurance, and Real Estate	58,132	79,937	27.3	3.37	4.04
Services	317,694	436,368	27.2	18.39	22.05
Public Administration and Armed Forces	142,135	161,359	11.9	8.23	8.15
TOTALS	1,727,372	1,978,756	12.7		

1/ Source: North Pacific Division, U. S. Army Corps of Engineers. Prepared from Census of Population Data Developed by Office of Business Economics, U. S. Department of Commerce.

Table 9 - Personal Income and Earnings, Columbia-North Pacific Region [1]
1940, 1950, 1960, and 1962

Area	Total Personal Income [2]				Per Capita Income [2]						
	1940 $ Millions	1950 $ Millions	1960 $ Millions	1962 $ Millions	1940 Dollars	% Change From 1940	1950 Dollars	% Change From 1950	1960 Dollars	% Change From 1960	1962 Dollars
United States	172,235,431	274,097,374	377,928,456	419,628,723	1,300	27.9	1,805	15.4	2,134	5.5	2,258
C-NP Region	4,649,108	8,921,575	11,675,887	12,981,737	1,348	30.1	1,929	11.6	2,182	6.2	2,325
Subregion 1	570,891	881,409	1,112,955	1,186,639	1,369	23.7	1,795	10.1	1,996	3.0	2,057
Subregion 2	159,971	322,118	392,475	446,751	1,227	39.8	2,040	0.5	2,050	9.7	2,271
Subregion 3	159,635	388,854	450,215	518,774	1,213	34.4	1,851	7.4	2,000	10.3	2,230
Subregion 4	188,993	357,783	490,785	541,700	916	40.2	1,531	17.5	1,856	4.2	1,938
Subregion 5	195,457	345,838	475,014	543,596	1,102	31.2	1,602	16.1	1,910	8.2	2,080
Subregion 6	137,145	271,288	310,958	325,720	1,002	44.8	1,816	10.1	2,021	0.5	2,032
Subregion 7	182,301	371,146	428,787	453,444	1,275	36.1	1,996	8.6	2,185	2.3	2,237
Subregion 8	121,773	230,790	245,039	273,020	1,091	38.9	1,786	5.8	1,897	7.2	2,045
Subregion 9	1,046,744	2,111,501	2,752,456	3,063,792	1,417	27.2	1,946	11.9	2,208	5.1	2,328
Subregion 10	279,325	630,269	740,343	769,633	1,188	37.6	1,905	3.1	1,966	3.4	2,034
Subregion 11	1,588,618	2,978,717	4,245,335	4,826,380	1,574	24.8	2,093	13.8	2,428	7.8	2,633
Subregion 12	18,255	31,862	31,525	32,288	1,570	36.7	2,479	-7.3	2,297	6.6	2,459

1/ Source: Office of Business Economics
2/ In 1958 dollars.

PERSONAL INCOME

Per capita income in the Columbia-North Pacific Region has compared favorably with the national averages in the past, exceeding the national level slightly in each of the census years 1940, 1950, and 1960.

Although the regional per capita income has been relatively high, there has been considerable disparity among the subregions. Data developed by the Office of Business Economics shows that in 1960, Subregion 4, Upper Snake, had a per capita income of only $1,856, while that of Subregion 11, Puget Sound, was $2,428. These same subregions also represented the two extremes at least since 1940. Table 9 presents statistics on per capita income for the subregions, region, and the Nation.

EDUCATION

Residents of the Columbia-North Pacific Region are better educated than those of the United States as a whole. In 1960, about one-half of the population had completed 12 or more years of education, substantially higher than the figure for the Nation.

The higher educational attainment was true generally for both males and females. Every 5-year age group, beginning with the 14-to-19-year age group, displayed higher educational attainment than the same group nationally. (1-34)

Table 10- Percentage Distribution of Population over 14 Years of Age, According to Years of School Completed Columbia-North Pacific Region and the United States 1/

Age	Elementary School		High School		College	
	0-7	8	1-3	4	1-3	4+
	COLUMBIA-NORTH PACIFIC REGION					
14-29	3.1	7.6	36.3	33.5	13.6	5.9
30-44	4.6	10.5	20.4	40.0	13.5	11.0
45-64	12.8	23.3	21.0	24.7	10.8	7.4
65 & Over	29.9	32.2	14.3	11.7	7.6	4.3
	UNITED STATES					
14-29	11.4	11.9	33.9	28.1	9.9	4.8
30-44	13.2	11.7	22.1	33.5	10.0	9.5
45-64	25.9	22.0	19.0	18.4	8.1	6.6
65 & Over	42.4	26.8	11.7	9.9	5.5	3.7

1/ Source: 1960 Census of Population, Vol. "Characteristics of the Population"; Part 1, U. S. Summary Table 173; Parts 14, 28, 39, and 49, Tables 101-103.

ESTHETIC AND CULTURAL CONSIDERATIONS

To attempt to discuss in a few pages the esthetic and cultural characteristics of the Pacific Northwest region is as difficult as to describe the quarter-million square miles of the region that contain such a varied pattern as the Rocky, Cascade, and coastal mountains, the vast Columbia River, the picturesque Puget Sound, the colorful Pacific Ocean front and all the green and fertile valleys, the orchards, and the wide-ranging arid country between the Cascades and Rockies. The capabilities of the region, its immense natural and man-modified resources are important only as they relate to Man and Man's activities. Man's activities are reflected in permanent impacts on his environment and by his culture whether in structures, philosophies, political systems, or esthetics.

Some notion of the natural esthetic quality present here is given by considering the region's devotion to national and state parks, public forests, seashores and beaches. There are great wilderness areas and wild rivers in abundance though not always protectively preserved. Whether from the new North Cascades National Park with its Picket Peaks, or Glacier National Park at Canada's border, there extend unending mountains, glaciers, cascading waters, serene lakes, and parched deserts. One after another, there are national parks, national forests, wilderness areas, cultivated lands, and Pacific shores. On the coast there are cool, damp rain forests of spruce and hemlock undercovered with mosses, lichens, ferns and oxalis stretching from the Pacific shore to the alpine meadows below stark peaks. Inland, there are the arid mountains--Steens, Wenatchee, and many, many others.

The beauty of all these features depends on many things. On a clear day, the mountaineer at the summit of a granite peak is filled with success, fatigue, and great vistas. Ten minutes later, a sudden electric storm transforms all this into a point of discomfort, if not fright. What was magnificent is now forbidding. Just so, the oceans, lakes, and sounds may move from scenes of majesty to scenes of awesome power as squalls scud by. The extent, the contrast, and the variety of this natural environmental heritage are difficult to describe to those who have not seen it.

The weather's influence varies so greatly that each locale has a seasonal beauty of its own. This is often unperceived by the preoccupied local individual; great seasonal color dramas await the visitor.

In the arid parts of the region, spring is a brief few days of emerald green; summer is hot, long, and brown, yielding slowly to a golden fall as plants cure. Sprinkled over this area are manmade oases, seven million acres of irrigated land. Then comes

winter and the snow-covered hills like giant gingerbreads powdered with sugar.

In contrast, is the ocean slope with green summers, brilliant fall days, golden cottonwoods, and fiery maples. Comes winter and a damp grayness settles down on the land to be interrupted by "Sou'westers," and following, wild, windy, warm days; the beaches are foamy and beachcombers come alive. Spring comes slowly to the coast, and is long. Trillium, skunk cabbage, and pussy willows are the harbingers of a leafing out and flowering of moisture-loving plants.

All of these lands are enlivened by wild animals, fish, and birds. There is no more stirring sight than a Chinook salmon challenging the raging river of its origin on its way to reproduce and die. Soaring eagles, clumsy pelicans, cranes, herons, ducks, and geese give life to the scene. A glimpse of a coyote, mountain lion or marten is only given to the alert and patient.

The natural magnificence is vast. The variety in color, in life, in feel, smell, sound, and sight is there to behold. If the foregoing description of the region seems glowing it is because there is widespread agreement that the Northwest is blessed indeed with a great natural beauty. The history of Man on this land goes back thousands of years. Archeologists have traced Man back about 10,000 years here. But it is mostly in the last 100 years that Man's impact has been truly felt, and it might safely be said that his recent hand has been heavy.

From its earliest white explorer days, the times of Captain Cook and Captain Vancouver, the fur era of the Astors, and the trading days of Hudson's Bay Company, the rough and tumble beginnings become more turbulent.

The mighty Columbia, greatest natural feature of the region, has changed. Once a free flowing boisterous giant, it has been transferred by Man in a generation to the most completely harnessed major river in the world. A series of pools hundreds of miles in length with structures athwart its course attesting to Man's ability to change nature for good or bad.

The settler and farmer brought with him cultural origins of New England and a puritanical ethic. But the transient frontiersman, later cowhands, miners, trappers, and loggers were another element. The managerial group, too, were exploitive in philosophy and from 1870 forward, devastating inroads were made on the forests, ranges, and the fisheries. Get-rich-quick, boom-or-bust was the nature of a period halted finally by the John Muirs, the Gifford Pinchots, and the Teddy Roosevelts.

It is misleading to say that the rough-and-tumble beginnings of the Pacific Northwest are still traceable in the urban areas because the homogenizing effects of mass information, easy communications, and travel have faded the colorful past to a too gray present. To discuss the manmade esthetic and cultural characteristics of such a region is impossible. But it may be helpful to attempt description of two or three of the great cities. In addition, a sampling description of the smaller communities may give some notion of the tone, the flavor, the feel of this region.

Seattle has a very brief history and is an excellent example of quick transition from the boisterous era of logging, shipping, fishing, and the gold-rush, quick-riches, to the contemporary. It is now more bland, more industrial, more service oriented and is an educational and cultural center. Seattle indeed has a flavor--drawn partly from its physical heritage of sparkling, natural beauty, and its boisterous beginning. A splendid, metropolitan city filled with contrasts has arisen from the ashes of its great 1890 fire.

The unusual long, narrow configuration of the queen city of the Northwest is yet an opulent body of land confined by unbelievably beautiful waters. In a few words, its homes run the architectural gamut from carpenter Gothic through the bungalow era of the 1920's to the present in which there is a mixture of the old, the new, the slick and the inspired. The metropolitan skyline is of 20 to 50-story buildings, very contemporary and sophisticated.

The city can boast significant collections of art and handsome public-building architecture. The Civic Center, left over from the 1962 World's Fair, is of unusual character. There are several universities of competent scholars. There are repertory theatre and musical organizations of brilliance.

Contrasted with this is also a city of mediocrity in its suburbs, a city of neon-strip communities, a city that has partially turned its back on its poor, and established suburban areas that have been scarcastically called "white ghettos." Yet, coincident with this is a city that has looked at its own shortcomings and developed, in 1966, a visionary plan for the future called "Forward Thrust."

Beginning as early as 1912, when the great landscape architect, Olmstead, developed the outlines of the city's park system, the beginnings of a culturally and esthetically attractive city were taking shape. By 1930, the end of the sawdust era was in sight and a one-industry city was about to give way to another single industry. The culture reflected in the lumber-town architecture of the period after the 1890 fire and the present architecture contrast as sharply as the industrial change that has occurred. The major industry, construction of giant jet aircraft, in this particular location

violates many of the concepts of industrial location, except that of locating in a pleasant, culturally-attractive environment. Nonetheless, jet aircraft is now the industry.

For contrast, another great city is Portland. Here is a city of more sedate, less tempestuous history. It has grown as a commercial center for an agricultural and forest-products industry. Although it had some of the boom-or-bust characteristics of the timber industry, it has had the balancing influence of a large, and stabilizing, agricultural economy. This is reflected in a city more closely attached to the traditions of the eastern United States, especially New England, and with less a flavor of its own. Although similar in size, it is architecturally less vivid. The physical setting of the city is great compared to many of the eastern and prairie cities, but is less spectacular than its neighbor, Seattle.

The city was not the site of any major university until after World War II, although there have long been several excellent smaller colleges. Its art, music, arthitecture, parks, reflect a less flamboyant people but with a substantial concern for cultural amenities.

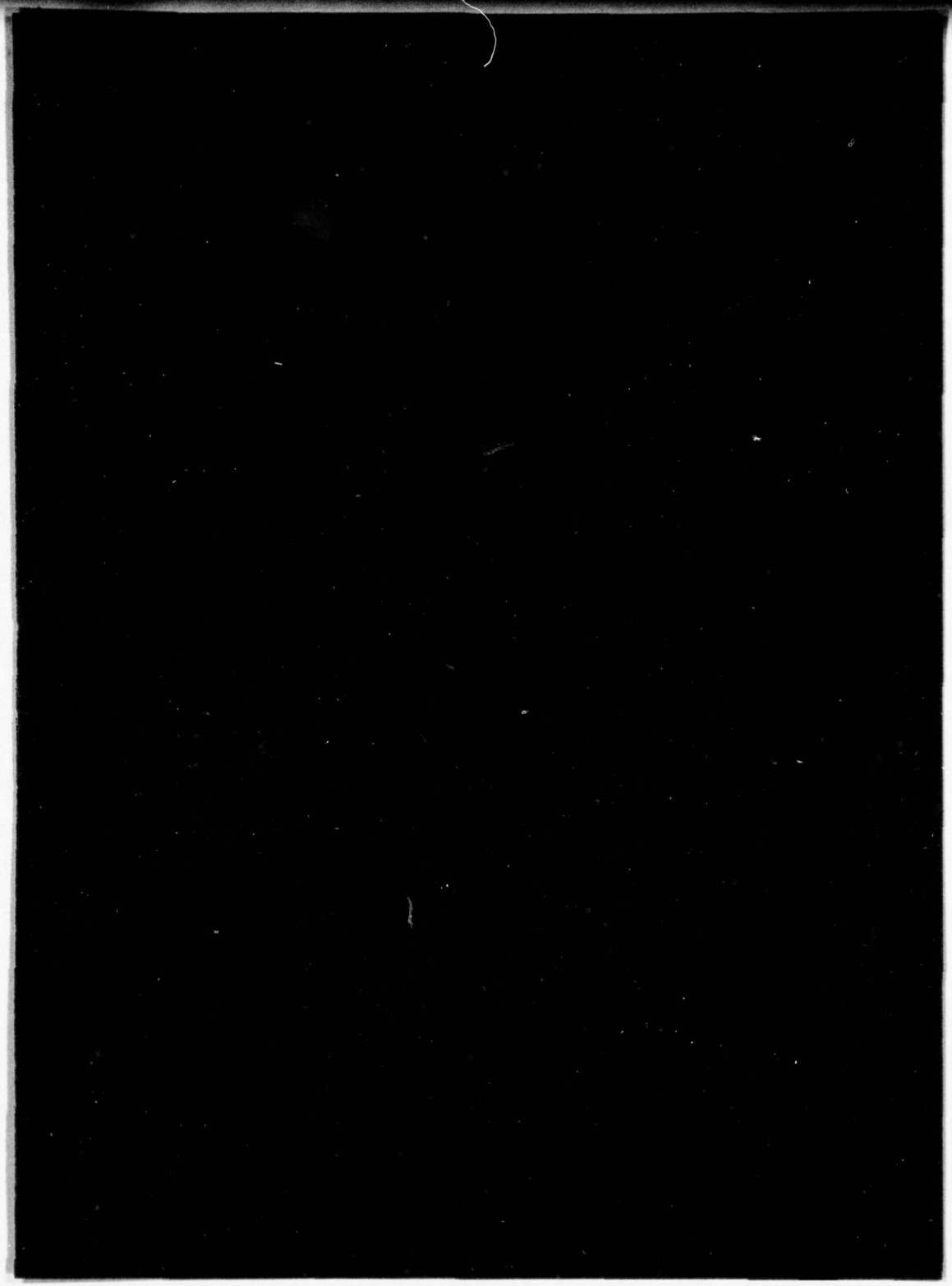
Tacoma presents still another view. Here forest industry is still king. Thus, smoke-based industry has resulted in a culturally and esthetically less attractive city. In an otherwise equivalent environment, Tacoma has permitted one of the most severe smog problems on the entire Pacific coast. With mild protest, the citizens of Tacoma have accepted this unsatisfactory arrangement and moved to the suburbs in numbers.

The inland empire city of Spokane has a staunch conservative history. It is a clean-air city with many esthetically pleasing attributes, particularly including the Spokane River. Here, there is less smoke-stack industry because this is the commerce and service center of a very large agricultural economy, with only partial commitment to forest industry. It is very attractive but somewhat less dynamic than the coastal cities and has disproportionately fewer educational and cultural features.

To contrast the greater cities with examples of smaller communities like Salem and Eugene, Oregon; Boise, Idaho; and Missoula, Montana, is too limiting. One might presuppose that attitude is a function of size; thus, the smaller the size, the more provincial the attitude and the less sophisticated the cultural and esthetic opportunities. However, significant cultural impacts are seen in each of these smaller cities caused by the presence of concerned populations and perhaps by large universities. Each of these cities has intrinsically an esthetically pleasing natural environment and each of these suffers less from the depredations of Man's activity. Perhaps there is less architectural

brilliance, but also they are relatively less devastated by the American strip city. The societies, hence the cultural interests, of these smaller cities tend to be more identifiably layered with a small, but affluent, owner group, a large middle segment and a significant, but somewhat hidden, poor population. These smaller communities are less amenable to change, but in each case has demonstrated much imagination with reference to the development of attractive parks, libraries, shopping areas, and cosmopolitan and sophisticated accommodations for the traveling public. Several have been named "All-American Cities," based on their achievements.

Overall, one might conclude that the Pacific Northwest is a region of great natural environmental features. The contrasts of topography and climate, the abundance of water, the spectacular mountains, the nearby wilderness, contribute to magnificent settings. By and large, the cultural impacts that Man has made on this setting have not been of the significance that they might have. The recent beginnings explain the lack of history. But blandness is resulting from mass media and mass culture and this explains much of what is current. The opportunities that have been foregone are emphasized by examples in the Northwest where Man has achieved something of quality, whether it be in the setting aside of space for parks, the construction of beautiful buildings, the development of great universities, or the preservation of some of the natural heritage. This is a region of such superb environment that it is deserving of superb planning, great public and private investment, susceptible to imagination, innovation, and challenge. It has been said, "High mountains are a feeling, but the hum of human cities, torture." One might ask, need this be so?



SUBREGIONS

INTRODUCTION

The Columbia-North Pacific Region was divided into 12 hydrologic subregions for study and reporting purposes. These subregions are shown by name and number on figure 17. Each of the 12 subregions is composed of a single basin or a combination of river basins which fit into a logical hydrographic pattern that could be used in most water-planning functions and for which readily available data have already been compiled.

The purpose of this section is to set forth, in a central place, a brief general description of the 12 subregions. The discussions that follow are concerned with the location, size, streams and major water developments, physical features, climate and distribution of land and population (i.e., those features that will allow one to locate the subregion and become familiar with its relationship to the total region). These descriptions are not intended to cover detailed aspects of economics, agriculture, land ownership, natural resources, history, etc., which are discussed elsewhere in this appendix or are the major purpose of other appendices.

The total area for the Columbia-North Pacific Region and each subregion is shown by States, in square miles and acres in table 11. Land and water surface areas are shown in tables 12 and 13, respectively, for the same areas and in the same units. To enable a comparison between the subregions, and of the subregions to the region, percentage relationships (such as total water, total land, etc.) are presented in table 14.

SUBREGION 1, CLARK FORK-KOOTENAI-SPOKANE

A green forest mantle, spread over numerous mountains and valleys cut by countless streams, is the typical landscape feature of the Clark Fork-Kootenai-Spokane Subregion.

The subregion, occupying the northeastern part of the region, is bounded on the north by Canada, along the east by the Continental Divide, and on the west and south by several drainage divides. It embraces 36,360 square miles (23,271,000 acres) or 13 percent of the Columbia-North Pacific Region. Seventy percent lies in western Montana, 21 percent in Idaho, and 9 percent in Washington. The land and water areas are summarized by States in table 15. Table 16 compares various features of the subregion to

Table 11- Total Area, by State & Subregion, 1967,
Columbia-North Pacific Region 1/

Sub-Region	Unit	Idaho	Montana	Nevada	Oregon	Utah	Wash.	Wyoming	Total
1	Thous.Acres	4,828.6	16,176.3	--	--	--	2,266.1	--	23,271.0
	Sq. Miles	7,544.6	25,275.5	--	--	--	3,540.8	--	36,360.9
2	Thous.Acres	--	--	--	--	--	14,368.9	--	14,368.9
	Sq. Miles	--	--	--	--	--	22,451.4	--	22,451.4
3	Thous.Acres	--	--	--	--	--	3,879.9	--	3,879.9
	Sq. Miles	--	--	--	--	--	6,062.3	--	6,062.3
4	Thous.Acres	18,445.2	--	973.6	--	240.9	--	3,288.8	22,948.5
	Sq. Miles	28,820.6	--	1,521.3	--	376.4	--	5,138.7	35,857.0
5	Thous.Acres	12,311.7	--	2,325.1	8,931.1	--	--	--	23,567.9
	Sq. Miles	19,237.1	--	3,633.0	13,954.8	--	--	--	36,824.9
6	Thous.Acres	15,720.0	--	--	3,171.6	--	3,560.1	--	22,451.7
	Sq. Miles	24,562.5	--	--	4,955.6	--	5,562.6	--	35,080.7
7	Thous.Acres	--	--	--	15,447.4	--	3,500.4	--	18,947.8
	Sq. Miles	--	--	--	24,136.6	--	5,469.3	--	29,605.9
8	Thous.Acres	--	--	--	168.8	--	3,097.3	--	3,266.1
	Sq. Miles	--	--	--	263.7	--	4,839.6	--	5,103.3
9	Thous.Acres	--	--	--	7,709.2	--	--	--	7,709.2
	Sq. Miles	--	--	--	12,045.7	--	--	--	12,045.7
10	Thous.Acres	--	--	--	11,067.9	--	4,140.7	--	15,208.6
	Sq.Miles	--	--	--	17,293.5	--	6,469.9	--	23,763.4
11	Thous.Acres	--	--	--	--	--	8,547.2	--	8,547.2
	Sq. Miles	--	--	--	--	--	13,355.0		13,355.0
12	Thous.Acres	--	--	--	11,458.3	--	--	--	11,458.3
	Sq. Miles	--	--	--	17,903.6	--	--	--	17,903.6
TOTAL	Thous.Acres	51,305.5	16,176.3	3,298.7	57,954.3	240.9	43,360.6	3,288.8	175,625.1
	Sq. Miles	80,164.8	25,275.5	5,154.3	90,553.5	376.4	67.750.9	5,138.7	274,414.1

1/ Source: Appendix IV, Land & Mineral Resources.

Table 12 - Land Area, by State & Subregion, 1967
Columbia-North Pacific Region 1/

Sub-Region	Unit	Idaho	Montana	Nevada	Oregon	Utah	Wash.	Wyoming	Total
1	Thous.Acres	4,665.0	15,921.6	--	--	--	2,232.8	--	22,819.4
	Sq. Miles	7,289.0	24,877.5	--	--	--	3,488.8	--	35,655.3
2	Thous.Acres	--	--	--	--	--	14,080.8	--	14,080.8
	Sq. Miles	--	--	--	--	--	22,001.3	--	22,001.3
3	Thous.Acres	--	--	--	--	--	3,851.4	--	3,851.4
	Sq. Miles	--	--	--	--	--	6,017.7	--	6,017.7
4	Thous.Acres	18,232.3	--	973.6	--	240.9	--	3,235.0	22,681.8
	Sq. Miles	28,488.0	--	1,521.3	--	376.4	--	5,054.7	35,440.4
5	Thous.Acres	12,193.5	--	2,322.9	8,881.1	--	--	--	23,397.5
	Sq. Miles	19,052.5	--	3,629.6	13,876.7	--	--	--	36,558.8
6	Thous.Acres	15,694.3	--	--	3,168.2	--	3,508.7	--	22,371.2
	Sq. Miles	24,522.3	--	--	4,950.3	--	5,482.4	--	34,955.0
7	Thous.Acres	--	--	--	15,366.6	--	3,455.6	--	18,822.2
	Sq. Miles	--	--	--	24,010.3	--	5,399.3	--	29,409.6
8	Thous.Acres	--	--	--	162.6	--	3,030.0	--	3,192.6
	Sq. Miles	--	--	--	254.1	--	4,734.4	--	4,988.5
9	Thous.Acres	--	--	--	7,602.8	--	--	--	7,602.8
	Sq. Miles	--	--	--	11,879.4	--	--	--	11,879.4
10	Thous.Acres	--	--	--	10,984.5	--	4,069.7	--	15,054.2
	Sq. Miles	--	--	--	17,163.2	--	6,358.9	--	23,522.1
11	Thous.Acres	--	--	--	--	--	8,446.6	--	8,446.6
	Sq. Miles	--	--	--	--	--	13,197.8	--	13,197.8
12	Thous.Acres	--	--	--	11,394.8	--	--	--	11,394.8
	Sq. Miles	--	--	--	17,804.3	--	--	--	17,804.3
Total	Thous.Acres	50,785.1	15,921.6	3,296.5	57,560.6	240.9	42,675.6	3,235.0	173,715.3
	Sq. Miles	79,951.8	24,877.5	5,150.9	89,938.3	376.4	66,680.6	5,054.7	271,430.2

1/ Source: Appendix IV, Land & Mineral Resources - Includes water areas under 40 acres and streams less than 1/8 mile wide.

COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

THE C-NP SUBREGIONS

1968

FIGURE 17

Table 13 - Water Area, by State & Subregion, 1967
Columbia-North Pacific Region 1/

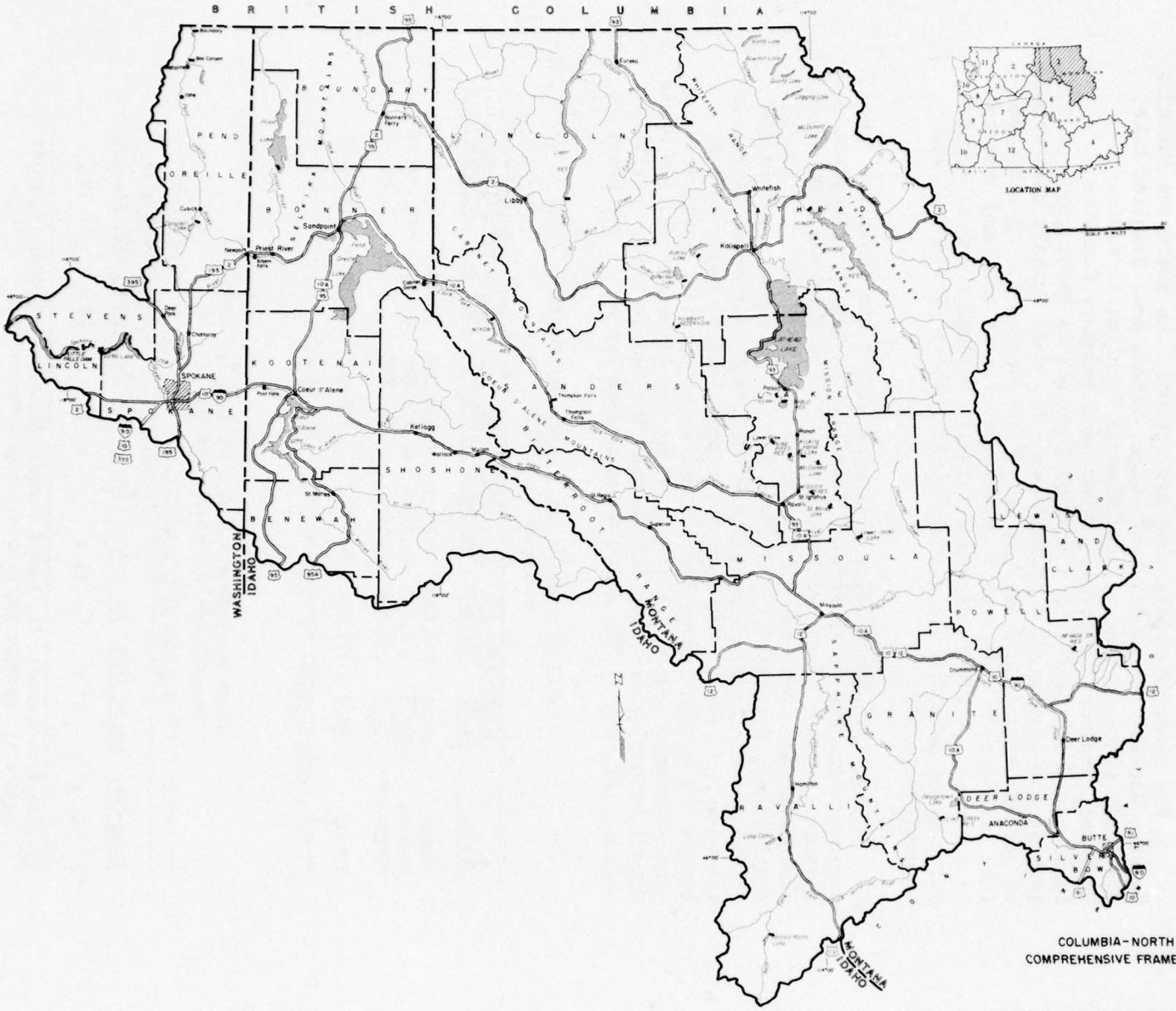
Sub-Region	Unit	Idaho	Montana	Nevada	Oregon	Utah	Washington	Wyoming	Total
1	Thous.Acres	163.6	254.7	--	--	--	33.3	--	451.6
	Sq. Miles	255.6	398.0	--	--	--	52.0	--	705.6
2	Thous.Acres	--	--	--	--	--	288.1	--	288.1
	Sq. Miles	--	--	--	--	--	450.1	--	450.1
3	Thous.Acres	--	--	--	--	--	28.5	--	28.5
	Sq. Miles	--	--	--	--	--	44.6	--	44.6
4	Thous.Acres	212.9	--	0	--	0	--	53.8	266.7
	Sq. Miles	332.6	--	0	--	0	--	84.0	416.6
5	Thous.Acres	118.2	--	2.2	50.0	--	--	--	170.4
	Sq. Miles	184.6	--	3.4	78.1	--	--	--	266.1
6	Thous.Acres	25.7	--	--	3.4	--	51.4	--	80.5
	Sq. Miles	40.2	--	--	5.3	--	80.2	--	125.7
7	Thous.Acres	--	--	--	80.8	--	44.8	--	125.6
	Sq. Miles	--	--	--	126.3	--	70.0	--	196.3
8	Thous.Acres	--	--	--	6.2	--	67.3	--	73.5
	Sq. Miles	--	--	--	9.6	--	105.2	--	114.8
9	Thous.Acres	--	--	--	106.4	--	--	--	106.4
	Sq. Miles	--	--	--	166.3	--	--	--	166.3
10	Thous.Acres	--	--	--	83.4	--	71.0	--	154.4
	Sq. Miles	--	--	--	130.3	--	111.0	--	241.3
11	Thous.Acres	--	--	--	--	--	100.6	--	100.6
	Sq. Miles	--	--	--	--	--	157.2	--	157.2
12	Thous.Acres	--	--	--	63.5	--	--	--	63.5
	Sq. Miles	--	--	--	99.3	--	--	--	99.3
Total	Thous.Acres	520.4	254.7	2.2	393.7	0	685.0	53.8	1,909.8
	Sq.Miles	813.0	398.0	3.4	615.2	0	1,070.3	84.0	2,983.9

1/ Source: Appendix IV, Land & Mineral Resources. Includes water bodies of more than 40 acres and streams more than 1/8 mile wide.

Table 14 - Summary of Data Comparing the 12 Subregions to the Columbia-North Pacific Region 1/

Subregion	Percent of Regional Total 2/					People per Square Mile
	Land Area	Water Area	Total Area	Average Discharge	Population	
1	13.1	23.6	13.2	11.7	11.7	17
2	8.1	15.0	8.0	1.7	3.6	9
3	2.2	1.3	2.2	1.0	4.1	28
4	13.0	14.0	13.0	2.8	5.0	10
5	13.5	9.0	13.3	2.5	4.6	8
6	12.9	4.3	12.7	9.7	2.8	5
7	10.8	6.7	10.7	4.4	3.5	7
8	1.8	3.7	1.8	8.1	2.2	35
9	4.4	5.7	4.4	12.4	23.6	102
10	8.6	8.0	8.6	28.2	6.8	22
11	4.8	5.2	4.8	16.8	32.7	121
12	6.5	3.3	6.5	0.5	0.1	0.7

1/ Source: Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; and Appendix VI Economic Base & Projections.
2/ Totals will not add to 100 percent due to rounding.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

CLARK FORK, KOOTENAI, SPOKANE SUBREGION 1

1968

FIGURE 18

the regional totals. Figure 18 shows the subregion's general features.

For economic studies and projections, the subregion includes Powell, Ravalli, Missoula, Deer Lodge, Silver Bow, Granite, Lake, Flathead, Lincoln, Sanders, and Mineral Counties in Montana; Shoshone, Benewah, Kootenai, Bonner, and Boundary Counties in Idaho; and Pend Oreille and Spokane Counties in Washington. A look at the distribution of land ownership data reveals that about 63 percent of the land area is in public ownership. At the same time, the land use data show over 80 percent of the land area to be forested. These two features greatly influence the subregion's patterns of development, resource utilization, settlement, and economic activity.

There are three major drainages within the subregion, the largest being the Clark Fork-Pend Oreille system. Its headwater tributaries rise along the Continental Divide from about 80 miles inside Canada, south to the juncture of the Idaho State line and the Divide. Principal tributaries are the Flathead River in the northeast and the Blackfoot, Clark Fork, and Bitterroot Rivers in the east and south. The Kootenai River, another major system, enters the United States from Canada about 40 miles east of the Idaho-Montana border. It is joined by the Fisher, Yaak, and Moyie Rivers before re-entering Canada near the middle of the northern boundary of Idaho. The third major stream system is the Coeur

Table 15 - Land & Water Areas, by States, Subregion 1, 1967 1/

State	Water Area 2/		Land Area		Total Area	
	Sq.Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Idaho	255.6	163,600	7,289.0	4,665,000	7,544.6	4,828,600
Montana	398.0	254,700	24,877.5	15,921,600	25,275.5	16,176,300
Washington	52.0	33,300	3,488.8	2,232,800	3,540.8	2,266,100
Total	705.6	451,600	35,655.3	22,819,400	36,360.9	23,271,000

1/ Data from Appendix IV, Land & Mineral Resources

Table 16- Comparison of Subregion 1, Clark Fork-Kootenai-Spokane, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
13.1	23.6	13.2	11.7	10.1	17

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

d'Alene-Spokane River system which drains the southwestern part of the subregion. Its principal tributaries are the Coeur d'Alene and St. Joe Rivers, which both drain into the Coeur d'Alene Lake.

There are some 705 square miles of water surface in the subregion including many beautiful natural lakes, the most prominent of which are Pend Oreille, Coeur d'Alene, and Priest in Idaho, and the Flathead in Montana. Development of the river systems has long been a key factor in the utilization of the subregion's natural resources. All three rivers are now, or soon will be, largely controlled by dams that provide power generation, irrigation, flood protection, and opportunities for recreation. Familiar names among dams serving these functions include Kerr, Hungry Horse, Libby, Albeni Falls, Noxon Rapids, and Boundary.

Average annual runoff is about 51,500 cfs (37.3 million acre-feet), of which about 20 percent originates in Canada. This runoff is a significant percentage (11.7 percent) of the total runoff of the region and amounts to an average discharge of 1.4 cfs per square mile. In 1965, approximately 2 percent of the mean discharge was consumptively used. Irrigation was the major use, followed by public supplies and industry.

The source of most of the streamflow is the snow which falls in the higher forested mountain areas. Practically all of the high mountain ranges contribute from 30 to 50 inches of runoff annually. The valley and foothill areas generally receive so little precipitation that their contribution to streamflow is negligible.

The local climate is greatly controlled by the elevation and topographic features. Summers are typically warm with little rainfall, while winter temperatures average below freezing for long periods. Windward sections receive as much as 100 inches of precipitation annually, while those areas in the rain shadows seldom get more than 10 inches.

Principal mountain ranges trend generally northward in roughly parallel lines, forming roughly rectangular drainage patterns. Examples of these ranges, of which there are more than a dozen prominent ones, are the Lewis, Mission, Whitefish, Bitterroot, and the main range of the Rocky Mountains in Montana; the Selkirks in Idaho; and the Chewelahs in Washington. The valleys between these ranges are generally narrow, with steep gradients. Elevations range from over 10,000 feet along the Continental Divide down to 1,289 feet at the mouth of the Spokane River.

Five major groups of rock are represented. They are the Belt Series (a thick sequence of metasedimentary rocks occupying the largest area), recent valley and terrace deposits, granite and related instrusive rocks, Paleozoic sediments, and volcanic extrusives.

The transportation network is constructed mainly in canyons and over the lower passes, which may or may not be direct routes. However, there are excellent highway and railroad systems connecting major cities and towns. Scheduled airlines serve the major urban centers.

Principal areas of employment are mining, agriculture, forestry, and recreation. Actual distribution within these sectors has been changing, reflecting a move away from primary production.

The 1965 population was 584,678 people. Most are concentrated in the major cities, with Spokane itself having nearly one-third of the total. Much of the remainder of the subregion is only sparsely populated.

While perhaps the scenic grandeur of the subregion reaches its pinnacle within Glacier National Park, the park is far from being the only attraction of national significance. Scores of trout streams, combined with thousands of square miles of mountain scenery, provide a setting for unparalleled recreational opportunities. The fish and wildlife resources are equally well-known for both their abundance and high quality.

SUBREGION 2, UPPER COLUMBIA

Typical of the Upper Columbia Subregion are the forest green mountains contrasting sharply with the desert brown lowlands which are steadily being turned to a productive green by irrigation. The subregion is located in north-central Washington, east of the Cascade Divide, west of the Spokane and Pend Oreille River Basins, and north of the Snake and Yakima River Basins. Figure 19 shows the subregion's general features and its location. Total size, as summarized below, is 22,451 square miles or approximately 8 percent of the regional total.

	Acres	Square Miles
Land Area	14,080,800	22,001.3
Water Area	288,100	450.1
Total Area	14,368,900	22,451.4

The subregion's boundaries are those of the Columbia River drainages above Pasco, Washington, within the United States, except the Yakima and Spokane Rivers. A comparison of the subregion to the total region is given in table 17.

For economic studies and projections, the subregion is

Table 17 - Comparison of Subregion 2, Upper Columbia, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
8.1	15.0	8.0	1.7	3.4	9

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

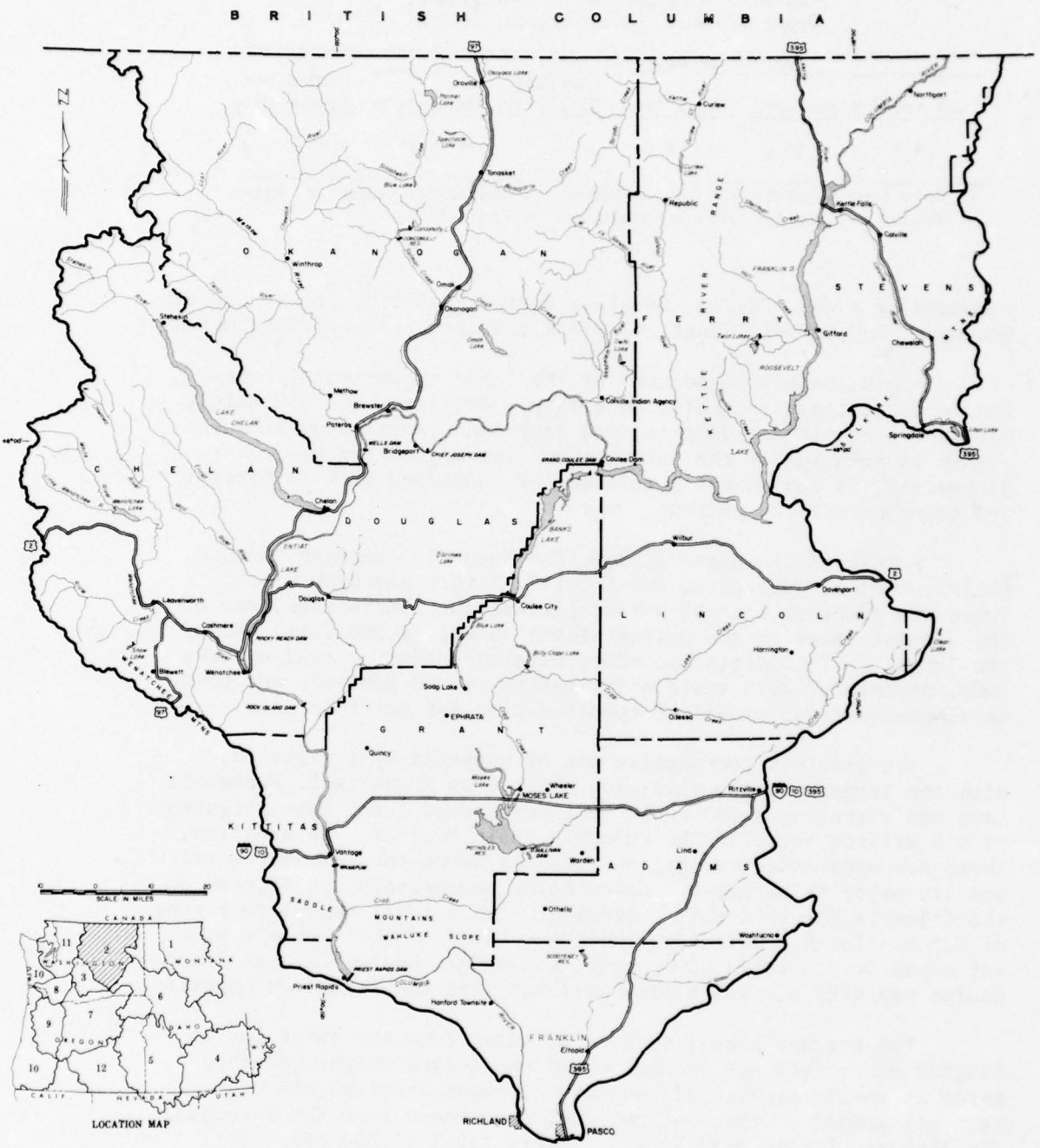
composed of Adams, Chelan, Douglas, Ferry, Franklin, Grant, Lincoln, Okanogan, and Stevens Counties, all within the State of Washington.

Approximately 53 percent of the lands are privately owned and 47 percent are in public ownership. Private lands are mainly devoted to croplands, forests, and rangeland, whereas public ownership is principally the latter two. The major land use, over 41 percent, is for forests, followed by rangeland with 33 percent, and cropland with 23 percent.

Principal drainages include the Sanpoil, Okanogan, Methow, Entiat, Chelan, Wenatchee, and Colville Rivers and Crab Creek. There are numerous natural lakes; picturesque Lake Chelan, one of the deepest lakes in the United States (nearly 1,500 feet), being the largest. In addition to these natural lakes, several manmade ones, associated with various irrigation, flood control, and power developments offer excellent opportunities for multiple uses.

The greatest consumptive use of water is by irrigation, with the largest single diversion being from Franklin D. Roosevelt Lake and averaging 3,000 cubic feet per second (cfs) for irrigation of 0.5 million acres in the Columbia Basin Project. In addition, there are many other irrigation projects along the Columbia River and its major tributaries. Seven major powerplants are located on the Columbia River in this subregion, with a total nameplate rating of 5.2 million kilowatts or almost one-third of the region's present capacity. A third powerplant, now under construction at Grand Coulee Dam, will add 3.6 million kilowatts to the installed capacity.

The average annual outflow of water from the subregion is 114,800 cubic feet per second, while the inflow of the Columbia River at the International Boundary averages about 95,800 cubic feet per second. Other inflows including those from the Okanogan, Similkameen, Kettle, and Spokane Rivers total 13,000 cfs. This leaves only 5,300 cfs of the total average outflow originating within the subregion.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

UPPER COLUMBIA SUBREGION 2

1968

FIGURE 19

Climatic conditions are extremely variable. Summers in the southern areas are relatively warm with temperatures 80° to 95° F. common and reaching 100° F. or higher on a few days. The highlands of the northern and western sections are generally somewhat cooler. Winters, sometimes under the influence of extensive Arctic air masses, are cold, with extremes to -50° F. having been recorded. Spring, summer, and fall climatic conditions along major river valleys make these areas highly suitable for fruit production. Precipitation totals reflect differences in elevation and location with respect to prevailing wind and adjacent topography. Great contrasts occur within short distances. In the Cascade Range, precipitation is more than 80 inches, with annual snow cover of more than 100 inches being common, but eastward and southward both snow depth and total precipitation decrease to a low of less than 10 inches annual precipitation in the channeled scabland area.

The rocks underlying the area include moderately to high metamorphosed sediments, with extensive areas of basalt of the Columbia River Group and granite intrusives. Positioned across the northern boundary are several north-south trending mountain ranges, their accompanying valleys containing sizable rivers. Together they make up what is commonly called the Okanogan Highlands. To the west is the Cascade Range, rising to elevations of nearly 10,000 feet. The central and southern part of the subregion is a part of the Columbia Plateau, underlain by a sequence of basalt lava flows. A distinctive feature of the plateau is the channeled scablands, an area of scarred canyons caused by outbreaks of glacial melt-water during the ice ages. The southeast corner borders on the Palouse Hills.

An excellent network of both railroads and highways serves the subregion, connecting both to the Puget Sound ports and to eastern markets. Plans call for navigation facilities to be further developed as far upstream as Wenatchee.

Principal sectors of employment are agriculture, forestry, and manufacturing; the latter showing a wide distribution from food processing to manufacture of ferroalloy products.

The 1965 population was 198,600 or about 3.4 percent of the regional total. Wenatchee, Pasco, and Moses Lake are the largest urban centers and serve as the major centers for distribution and processing of the local products. Of the small towns and villages scattered throughout the southern section, those associated with the irrigation projects have grown significantly in the past 25 years.

SUBREGION 3, YAKIMA

The Yakima River Basin is a major valley, fringed on the

west by forest-covered mountains and surrounded on three other sides by semi-arid land. As can be seen on figure 20, it is composed entirely of the drainage of the Yakima River and is located in central Washington, surrounded on the north, east, and south by the Columbia River system and on the west by the Cascade Mountains. It is the next to the smallest subregion, accounting for only approximately 2.2 percent of the total regional area. A summary of the land and water areas is presented below, and a comparison to the remainder of the region is shown in table 18.

	Acres	Square Miles
Land Area	3,851,400	6,017.7
Water Area	28,500	44.6
Total Area	3,879,900	6,062.3

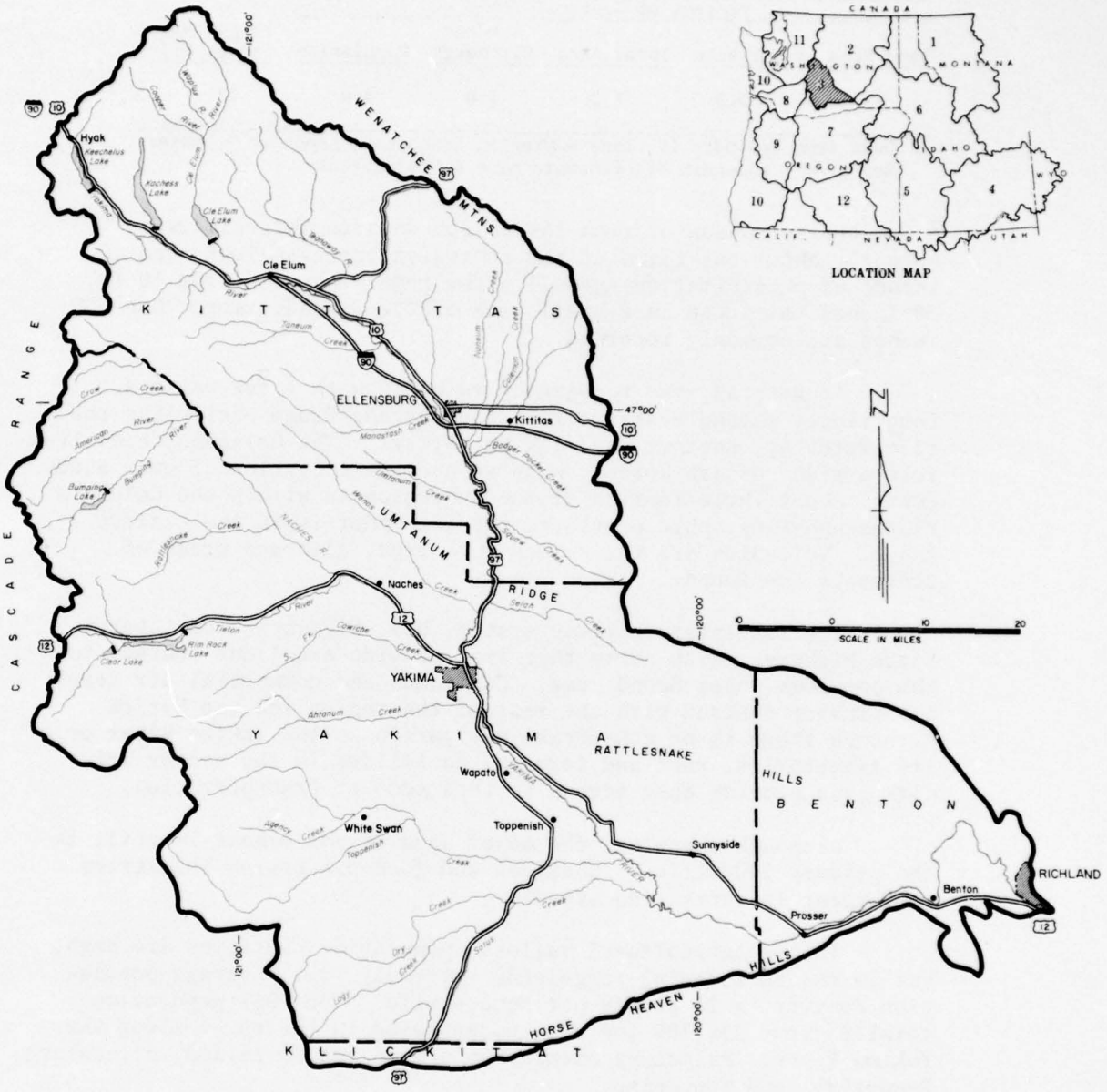
For economic study and projections, the subregion includes the following counties: Kittitas, Yakima, and Benton, all in Washington.

Slightly more than 60 percent of the land within the subregion is publicly owned. A number of national forests, a firing range, and the Hanford works of the U. S. Atomic Energy Commission are all or partly within the subregion. In addition, there are scattered Public Domain Lands and the major portion of the Yakima Indian Reservation.

All of the principal streams drain the east slope of the Cascade Range. The Yakima River is the central drainage into which flow, in the north, the Kachess and Cle Elum Rivers. To the south is the Naches River, which has two major tributaries--Bumping and Tieton Rivers. Issuing from the foothills of the Cascade Range are the North and South Forks of Ahtanum Creek. The average annual runoff originating within this subregion amounts to about 3,240 cubic feet per second (2.35 million acre-feet) or about 1 percent of the total regional runoff. The high runoff period occurs in May and June and generally drops to its lowest point in August.

Irrigation, the largest use of water, annually diverts about 2.5 million acre-feet. Other water uses are a small percentage of irrigation use; however, their peak demand coincides with low natural streamflows. There is also some power generation along the Yakima River.

Similar to all of the area east of the Cascade Range, total precipitation in this subregion is low and the temperature range is large. Recorded temperatures range from -25° F. to 115° F.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

YAKIMA SUBREGION 3

1968

FIGURE 20

Table 18 - Comparison of Subregion 3, Yakima, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
2.2	1.3	2.2	1.0	4.0	28

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

A frost-free season of from 160 to 200 days in the valleys is normal. About one-third of the subregion receives less than 10 inches of precipitation annually; the remaining area from 10 to 30 inches, although in a small area of the Cascades more than 100 inches are commonly recorded.

In general, the topography is hilly with a few valleys. Long ridges extend eastward from the Cascade Range encircling the flat Kittitas, Ahtanum, and Yakima Valleys. The Cascades themselves form a wide western border, with an average elevation of over 5,000 feet. About three-fourths of the subregion is within the Columbia Plateau physiographic province; the remainder is in the Cascade Range. Volcanics are the common rock type, although areas of sediments are found.

The interstate highway system, U.S. Highways, and several State highways which serve this area provide excellent contact to the populous Puget Sound area. Railroads and commercial air service provide contact with the rest of the region and the Nation. Although there is no commercial navigation on the Yakima River or its tributaries, port and terminal facilities in the nearby Tri-City area provide easy access to this mode of transportation.

Although changing, the major area of employment is still in the primary industries. Chemical and food processing industries employment is increasing steadily.

In the agricultural valleys, population densities are high, but in the surrounding rangelands extremely low. Average population density is 28 people per square mile. The 1965 population totaled about 236,700 and was concentrated in the towns along the Yakima River. Principal among them are Yakima, Richland, Ellensburg, Sunnyside, and Toppenish.

One of the most important features of this area is the high percentage of the agricultural area devoted to the raising of fruit crops. The Yakima Valley apples, along with those raised in Subregion 2, are nationally known as among the finest available. In addition, several other specialty crops such as grapes, peaches,

and hops are grown. This extensive agricultural development placed Yakima County as 14th among the Nation's counties in terms of agricultural production in 1964. The irrigated area of about 0.5 million acres is largely responsible for this production record.

SUBREGION 4, UPPER SNAKE

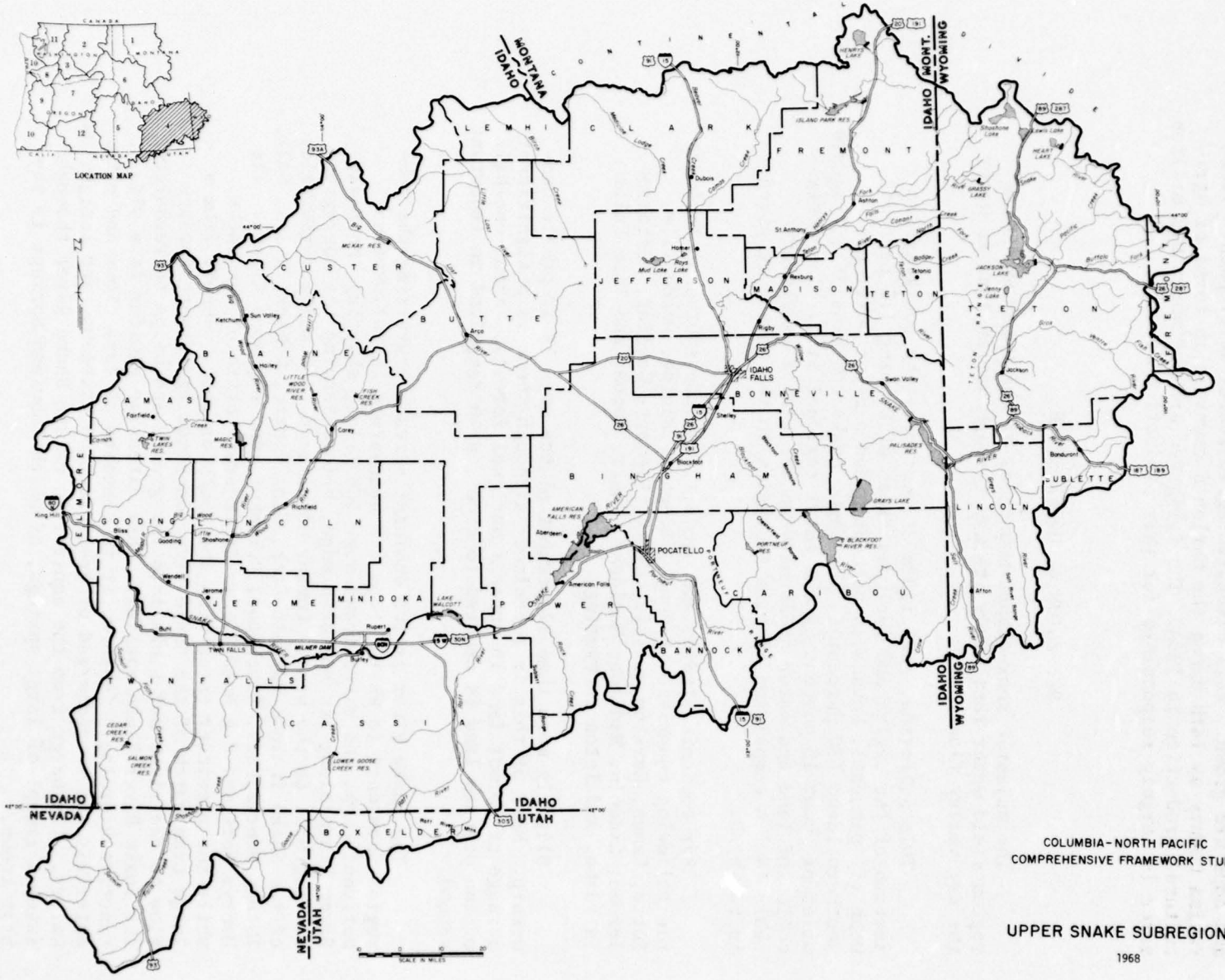
The majestic snow-capped mountains of the Upper Snake Subregion yield water that winds its way through barren land to water the dry valley floor.

This subregion, see figure 21, occupies the southeastern section of the region and includes areas of Wyoming (15 percent), Utah (1 percent), Nevada (4 percent), and a major portion of southern Idaho (80 percent). The Upper Snake contains 35,857 square miles or about 13 percent of the total regional area. The distribution of land and water areas between the states is shown in table 19. A comparison of this subregion to the region is given in table 20.

For economic studies and projections, the subregion includes the following counties: Bannock, Bingham, Blaine, Bonneville, Butte, Camas, Caribou, Cassia, Clark, Fremont, Gooding, Jefferson, Jerome, Lincoln, Madison, Minidoka, Power, Teton, and Twin Falls in Idaho, and Teton in Wyoming.

Slightly more than 72 percent of the area is in public ownership. Most of this is rangeland, although there is a significant acreage of forest land in several national forests. About one-half of the private land is devoted to crops, with rangeland an important second.

The Snake River is the dominant stream, traversing the subregion from east to west. From its headwaters in Yellowstone National Park, the river flows some 500 miles, skirting the Snake River Plain along its southern edge, before leaving the subregion at King Hill on the west. Coming downstream, the major tributaries of the Snake include Buffalo Fork, Gros Ventre, Hoback, Greys, Salt, Teton, Henrys Fork, Blackfoot, Portneuf, and Big Wood Rivers. The Henrys Fork and Big Wood Rivers drain areas north of the Snake, while the remainder enter from the south or west. Runoff from a large area north of the Snake River does not contribute surface flow to the river but sinks into the ground and helps to recharge the Snake River Plain aquifer. This extensive aquifer is a distinctive hydrologic feature; it is composed of lava flows and other materials and is recharged by precipitation, streams, and irrigation waters. Discharge from the aquifer is to the Snake River through several groups of large springs, of which Thousand Springs is the best known.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

UPPER SNAKE SUBREGION 4

1968

FIGURE 21

Table 19 - Land & Water Area, by State, Subregion 4, 1967 [1/]

State	Water Area		Land Area		Total Area	
	Sq.Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Idaho	332.6	212,900	28,488.0	18,232,300	28,820.6	18,445,200
Nevada	0.0	0	1,521.3	973,600	1,521.3	973.600
Utah	0.0	0	376.4	240,900	376.4	240,900
Wyoming	84.0	53,800	5,054.7	3,235,000	5,138.7	3,288,800
Total	416.6	266,700	35,440.4	22,681,800	35,857.0	22,948,500

1/ Data from Appendix IV, Land & Mineral Resources

Table 20 - Comparison of Subregion 4, Upper Snake, to the Region, 1967 [1/]

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
13.0	14.0	13.0	2.8	5.1	10

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

It was estimated in 1965 that an average water withdrawal of 17,800 cfs was made; approximately 99 percent was used for irrigation. The remaining withdrawals were made primarily for municipal and industrial uses. In addition, much of this same water was used for nonconsumptive recreation and power generation as well. The total amount used for power in 1965 amounted to 51,500 cfs. Navigation is limited to pleasure craft for fishing and other water recreation. The rivers are also used for dilution and transport of waste materials, both municipal and industrial.

Large Snake River reservoirs include American Falls and Palisades in Idaho, and Jackson Lake in Wyoming; together they have nearly 4 million acre-feet of active storage capacity. Major tributary reservoirs include Island Park, Blackfoot, Magic, Grays Lake, and Salmon Creek.

The climate is similar to much of the interior area. The summers are generally hot and dry and the winters are generally cool and moist. There are significant rain shadows in the mountain valleys, and the eastern portion of the subregion receives some summer moisture and winter cold from the continental air masses. The average annual temperature at stations on the Snake River Plain ranges from 40° F. to 50° F., while extremes range from -40° F. to 110° F.

The Snake River Plateau is the most prominent land form of

the subregion. It is bordered by mountain ranges on the north, east, and south. The level plain is underlain by extensive lava flows, which are exposed over large areas. A most notable example of recent volcanic activity can be seen at the Craters of the Moon National Monument. To the north, the Snake River Plateau joins the northern Rocky Mountain physiographic province, which includes several rugged mountain ranges rising to elevations in excess of 12,000 feet. The Teton Mountains lie to the east, rising abruptly from the plateau to elevations of almost 14,000 feet. A series of parallel mountain ranges are scattered across the southern edge of the subregion.

Total population for the subregion was nearly 302,000 people according to 1965 estimates. Although population density is low (about 10 people per square mile), there are several large towns located along the Snake River. These towns are Pocatello, Idaho Falls, and Twin Falls. Together they account for nearly one-third of the population.

The major concentration of primary and secondary employment is in agriculture, food processing, and chemical products.

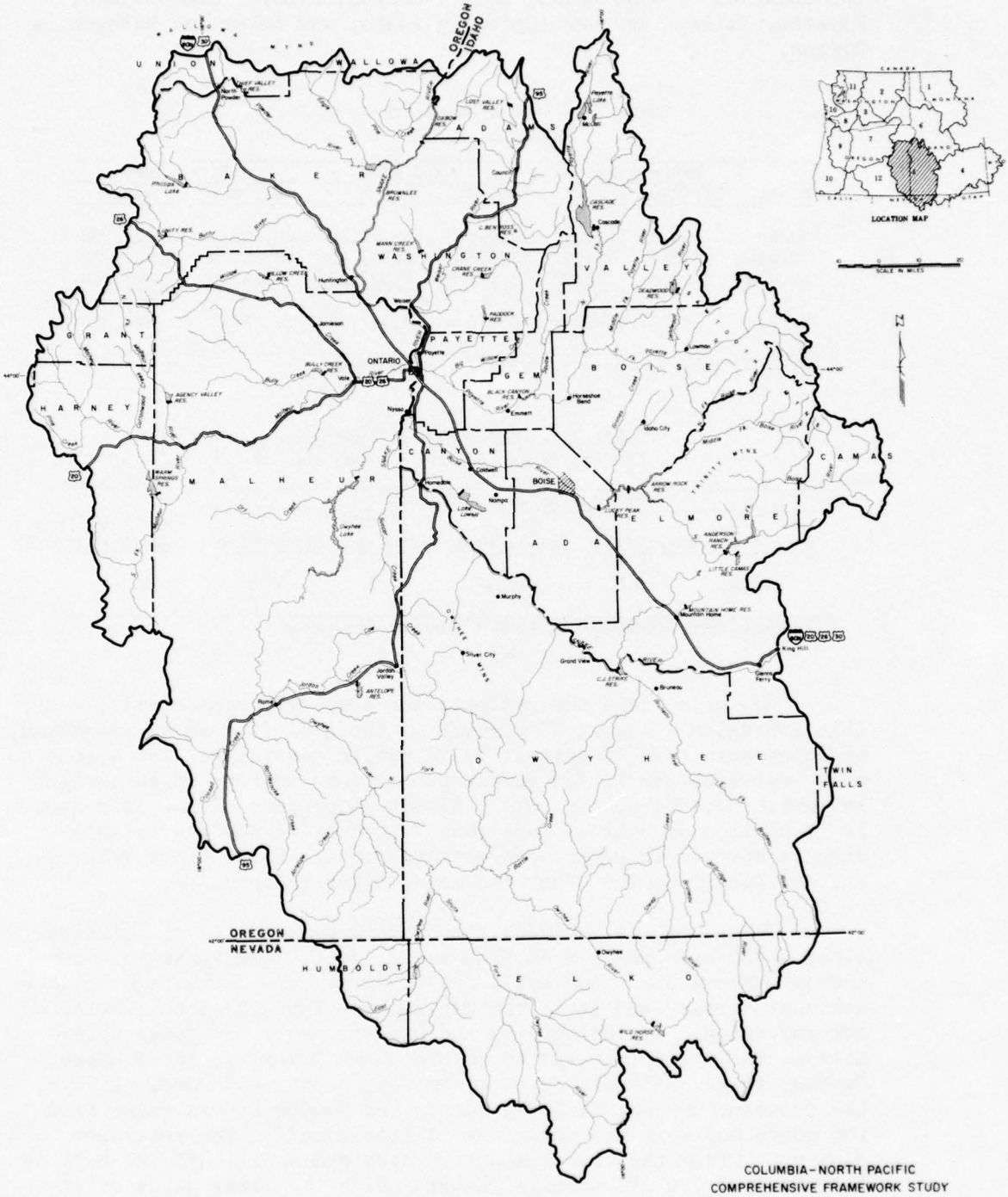
From east to west through this subregion passes one of the most important transportation routes of the region. Both major railroads and highways use the Snake River Valley as an approach to crossing the Rocky Mountains. Several cities are served by regular scheduled airlines.

Almost one-third of the total irrigated acreage of the Columbia-North Pacific Region is in this subregion. It includes some of the first irrigated land, with water flowing to large areas by the late 1800's. It accounts for a high percentage of the employment and economic activity.

SUBREGION 5, CENTRAL SNAKE

A vast semi-desert area adjoining a wide irrigated valley with a northern backdrop of rugged mountains forms the picture of the Central Snake Subregion.

This subregion occupies southeastern Oregon and southwestern Idaho, plus a small portion of northern Nevada. It has an areal extent of more than 200 miles east-to-west and nearly 300 miles north-to-south. Fifty-two percent of the area is in Idaho, 38 percent in Oregon, and 10 percent in Nevada. It is the largest of the 12 subregions, containing about 36,824.9 square miles (table 21) or 13.3 percent of the regional area (table 22). The subregion's relationship to the region and its general features are shown on figure 22.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

CENTRAL SNAKE SUBREGION 5

1968

FIGURE 22

For economic study and projections, the subregion includes the counties of Ada, Adams, Boise, Canyon, Elmore, Gem, Owyhee, Payette, Valley, and Washington in Idaho; and Baker and Malheur in Oregon.

Table 21 - Land & Water Areas, by State, Subregion 5, 1967 1/

State	Water Area		Land Area		Total Area	
	Sq. Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Idaho	184.6	118,200	19,052.5	12,193,500	19,237.1	12,311,700
Oregon	78.1	50,000	13,876.7	8,881,100	13,954.8	8,931,100
Nevada	3.4	2,200	3,629.6	2,322,900	3,633.0	2,325,100
Total	266.1	170,400	36,558.8	23,397,500	36,824.9	23,567,900

1/ Data from Appendix IV, Land & Mineral Resources

Table 22 - Comparison of Subregion 5 Central Snake, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
13.5	9.0	13.3	2.5	4.6	8

1/ Data from Appendix IV, Land & Mineral Resources

The major land use reflects the semi-arid characteristic of this subregion. Almost 72 percent of the area is used as rangeland, of which more than 77 percent is in public ownership. The second most important use is for forest production, most of which is also in public ownership. In total, almost 75 percent of the land area is in public ownership. Less than 7 percent of the subregion's area is devoted to crops, concentrated in the Snake River Valley, and surrounded by the other two major types of land use.

The subregion includes the Snake River and its tributaries along a 280-mile reach from King Hill, Idaho, downstream to about midway between Oxbow and Hells Canyon Dams. The Snake River is the dominant stream, and it is the drainageway for all water leaving the subregion. Beginning with the upper reaches and going downstream, the major tributaries of the Snake River are the Bruneau, Owyhee, Boise, Malheur, Payette, Weiser, Burnt, and Powder Rivers. The Bruneau, Owyhee, Malheur, Burnt, and Powder Rivers enter from the south and west and contribute little runoff. The remainder flow south from the higher mountain area and contribute the bulk of the nearly 7,700 cfs average runoff, which the river gains as it traverses the subregion.

Average annual flow into the subregion at King Hill is about 8,600 cfs and outflow at Oxbow is 16,300 cfs, an increase of 7,700 cfs within the subregion. Withdrawal of 8,410 cfs was made in 1965 from the subregion's streams. Approximately 97 percent was for irrigation and the remainder was primarily for self-supplied industrial uses and rural and public supplies. The total average water usage in 1965 for hydroelectric power generation was 59,000 cfs. Fishing and boating are popular recreation activities on most streams, lakes, and reservoirs, particularly on those which are close to urban areas. Another use is dilution and transport of municipal and industrial waste material.

There are more than 30 reservoirs in the subregion with a capacity of 5,000 acre-feet or more. These reservoirs serve the above-listed uses, in addition to flood control.

Hot, dry summers and cool winters are the common climatic features of the Central Snake Subregion. Most of the precipitation falls during the winter from frontal storms moving in from the Pacific Ocean; however, during the summer months thunder showers deposit significant rainfall totals in small areas. The valley and plateau areas receive only 6 to 15 inches a year, but the mountains average as much as 70 inches in isolated areas. Much of the higher elevation precipitation falls as snow, some of which does not melt until June, providing an important source of runoff to the streams. Summer drought conditions are a common characteristic, with precipitation averaging less than an inch throughout most of the subregion. Average annual temperatures range from 50° F. and higher at the lower elevations to 40° F. or less at the higher stations. Extremes range from over 110° F. to -20° F. at many of the lower stations, with extremes at the higher stations ranging from about 100° F. to as low as -50° F.

Situated across the northern portion of the subregion are several mountain ranges associated with the northern Rocky Mountain physiographic province. To the south is the Snake River Plateau through which the Snake River winds its way westward. The river has, in some places, cut deep canyons which reach their greatest depth of over a mile in Hells Canyon; in other places it flows at valley level. The elevation of the plateau increases southward to the headwater areas of the Owyhee and Bruneau Rivers.

Rock types vary from the extensive basalt and rhyolite flows of the plateaus, which are intermingled with lake-bed sediments, to the granitic rocks of the Idaho batholith.

Interstate Highway 80N crosses the area from the northwest to the southeast, roughly following the Snake River Valley. Following the same general path is the major railroad route. Both of these transportation media provide excellent contact with the

west coast and eastern markets. Air transport facilities are concentrated in Boise, the hub of economic activity.

Employment data show that the major concentrations in primary and secondary employment are in agriculture, forestry, and food processing. The employment in the food processing sector has increased rapidly in the past 25 years.

In 1965 there were slightly more than 268,000 people living in the Central Snake Subregion, an average of 8 people per square mile. A large part of the area has few, if any, inhabitants; the agricultural valleys, however, are thickly settled. Major towns include Boise, Nampa, Caldwell, and Mountain Home in Idaho; and Baker and Ontario in Oregon.

Irrigation projects, financed both privately and from Federal sources, have been a significant factor in the economic development of the subregion. Continued development and planning are taking place bringing new land under irrigation.

SUBREGION 6, LOWER SNAKE

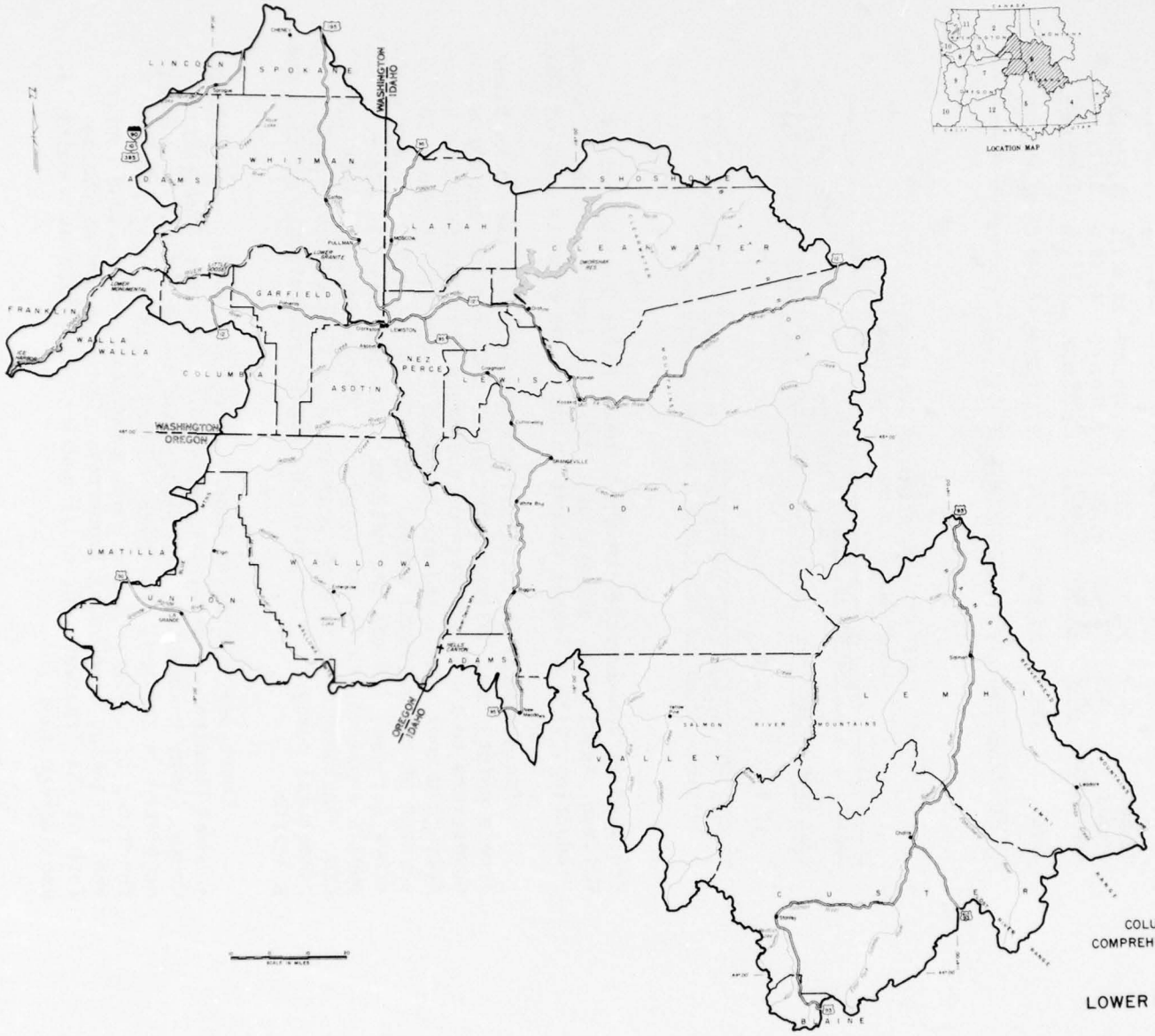
The rolling lands of the Palouse Hills, the deep canyons of the Snake River, and the high peaks of the Wallowa and Rocky Mountains make Subregion 6, the Lower Snake, an area of great contrast.

Located in central Idaho, southeastern Washington, and northeastern Oregon, this subregion contains some of the most rugged topography in the Columbia-North Pacific Region. Figure 23 shows its general features and relationship to the remainder of the region.

The total area of 22.5 million acres is equal to 12.7 percent of the regional total. A percentage distribution among the states shows that Idaho has 70 percent, Oregon 14 percent, and Washington 16 percent. Table 23 gives the land and water areas by states, while table 24 compares the subregion to the region.

For economic study and projections, the subregion includes the counties of Clearwater, Custer, Idaho, Latah, Lemhi, Lewis, and Nez Perce in Idaho; Union and Wallowa in Oregon; and Asotin, Garfield, and Whitman in Washington.

Approximately 65 percent of the land area of the Lower Snake Subregion is in public ownership. Of the public land, 80 percent is forested and 17 percent is rangeland. Private land is distributed between three major use categories in the following manner--cropland 39 percent, forest land 23 percent, and rangeland 33 percent.



COLUMBIA–NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

LOWER SNAKE SUBREGION 6

1968

FIGURE 23

Table 23 - Land & Water Areas, by State, Subregion 6, 1967 [1]

State	Water Area		Land Area		Total Area	
	Sq.Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Idaho	40.2	25,700	24,522.3	15,694,300	24,562.5	15,720,000
Oregon	5.3	3,400	4,950.3	3,168,200	4,955.6	3,171,600
Washington	80.2	51,400	5,482.4	3,508,700	5,562.6	3,560,100
Total	125.7	80,500	34,955.0	22,371,200	35,080.7	22,451,700

1/ Data from Appendix IV, Land & Mineral Resources

Table 24 - Comparison of Subregion 6, Lower Snake, to the Region, 1967 [1]

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
12.9	4.3	12.7	9.7	2.8	5

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

Cropland is concentrated in the Palouse Hills located around Pullman, Washington, and Moscow, Idaho, an important area of wheat production, with a lesser amount in the Camas Prairie area of Idaho.

The drainage includes all streams entering the Snake River from a point about halfway between Hells Canyon Dam and Oxbow Dam, downstream to the confluence of the Snake with the Columbia River. Average annual runoff amounts to about 31,800 cfs or about 10.7 percent of the regional total. Of this total, 1,320 cfs are withdrawn for use, 170 cfs for self-supplied industry, 39 cfs for public supplies, while the major use, irrigation, utilizes 1,094 cfs. Instream uses include generation of hydroelectric power; commercial navigation to Lewiston, Idaho; recreation, and fish and wildlife.

There are five major dams on the Lower Snake, one of which --Lower Granite--is under construction. The other four--Little Goose, Lower Monumental, Ice Harbor, and Hells Canyon--have been completed in the past few years. These serve principally the functions of navigation and power generation, with flood control and irrigation also being important. Dworshak Dam on the north fork of the Clearwater River is nearing completion as a multiple-use storage facility.

There are marked differences between the climatic conditions

of the mountains and the lowlands. Mountain summers are cool, while lowland summers are warm to hot. Winters follow the same regime with cold conditions prevailing in the mountain areas and mild temperatures in the lowlands. However, the lowlands do have extreme cold periods. In general, the average winter daily temperatures range from 10° to 40° F., and the summer temperatures range from 50° to 75° F. Extremes of 110° F. to -50° F. have been recorded. Most of the precipitation falls during the winter, leaving the summers dry. Average annual precipitation ranges from less than 10 inches in the lowlands to almost 80 inches on some mountain areas.

Subregion 6 occupies portions of two major physiographic provinces--the Northern Rocky Mountains and the Columbia Plateau. The Northern Rocky Mountain terrain, occupying the southern and northeastern part, is generally mountainous, with deep narrow valleys. In this part of the subregion, the highest mountain peaks rise to more than 12,000 feet, while the lowest part of the province at the mouth of the Salmon River is only 1,000 feet. The Columbia Plateau, lying in the northwestern part of the subregion, includes river canyons, basalt plateaus, and the Palouse Hills. Elevations here range from 5,500 feet just west of Hells Canyon to about 340 feet at the confluence of the Snake River with the Columbia River. Rising to an elevation of nearly 10,000 feet are the Wallowa Mountains, a part of the Blue Mountain Range. The major rock types are basalt, metamorphosed and unmetamorphosed sediments, and granitic intrusions.

The Rocky Mountains constrict the road and rail routes eastward. However, the routes to the west provide excellent connections with markets for the movement of the subregion's products. Limited navigation on the Snake River is now possible to Lewiston, Idaho, but commercial barge service will be available with the completion of the dam now under construction. Specially constructed river boats also haul freight, mail, and passengers into the remote portion of the Snake River known as Hells Canyon. Scheduled air service is available in most of the larger cities.

Employment data in the primary and secondary sectors show the major concentration to be in agriculture and forestry. Manufacturing employment is distributed between several industries with food processing and paper manufacturing having the most employees.

The 1965 population was about 163,250 or 2.8 percent of the total regional population. The population density averages about five persons per square mile, compared to more than 20 for the region. The important towns include Pullman and Clarkston, Washington; La Grande, Oregon; and Moscow and Lewiston, Idaho.

Diversity is the key word in the description of the Lower

Snake Subregion. From lowlands to high mountains, from dry lands to permanent snow, from sagebrush to forest, from primitive areas to busy cities, diversity is everywhere evident.

SUBREGION 7, MID COLUMBIA

An arc of forest covered mountains, dissected by the region's major stream and encompassing a semi-arid plateau, are the major landscape features of the Mid Columbia Subregion. Lying astride the Columbia River, Subregion 7 is located in north central Oregon and south central Washington. Eighty-two percent of its area is in Oregon and 18 percent is in Washington. The subregion's general features and its relationship to the remaining region are shown in figure 24.

As shown in table 25 and table 26, this is the fifth largest subregion and has an area of 29,606 square miles or 10.7 percent of the regional area.

For economic studies and projections, the counties in Oregon are Crook, Deschutes, Gilliam, Grant, Hood River, Jefferson, Morrow, Sherman, Umatilla, Wasco, and Wheeler; and in Washington are Columbia, Klickitat, and Walla Walla.

Departing from the normal land ownership pattern of the semi-arid section of the region, approximately 60 percent of the land area is privately owned and 40 percent is public land. Private land is distributed between the three major uses as follows--cropland 33 percent, forest land 21 percent, and rangeland 44 percent. Seventy-five percent of public land holdings is forest lands, while 20 percent is rangeland.

As its name indicates, this subregion is closely associated with the Columbia River. All drainage is into the Columbia, principally via the Walla Walla, Umatilla, John Day, Deschutes, and Hood Rivers from the south and the Klickitat and White Salmon Rivers from the north. These streams provide spawning and rearing areas for important populations of anadromous and resident fishes. There are numerous main stream and tributary reservoirs; the major ones being Wallula, Umatilla, Celilo, and Bonneville Reservoirs on the Columbia River; Lake Simtustus, Billy Chinook Lake, Ochoco, Wickiup, Prineville, and Crane Prairie Reservoirs on the Deschutes and its tributaries; and McKay and Cold Springs on the Umatilla River.

Average annual runoff generated within the subregion is approximately 15,400 cfs, of which about 6.4 percent was consumed in 1965. Again, irrigation is the major use, accounting for 2,585 cfs of the 2,940 cfs withdrawn. The total municipal use was 87 cfs and for self-supplied industry 258 cfs.

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COMPREHENSIVE FRAMEWORK STUDY

MID COLUMBIA SUBREGION 7

1968

FIGURE 24

Table 25 - Land & Water Areas, by State, Subregion 7, 1967 [1/]

State	Water Area		Land Area		Total Area	
	Sq.Mi.	Acres	Sq.Mi.	Acres	Sq. Mi.	Acres
Oregon	126.3	80,800	24,010.3	15,366,600	24,136.6	15,447,400
Washington	70.0	44,800	5,399.3	3,455,600	5,469.3	3,500,400
Total	196.3	125,600	29,409.6	18,822,200	29,605.9	18,947,800

1/ Data from Appendix IV, Land & Mineral Resources

Table 26 - Comparison of Subregion 7, Mid Columbia, to the Region, 1967 [1/]

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
10.8	6.7	10.7	4.4	3.6	7

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

Generation of hydroelectric power is an important instream use, utilizing most of the Columbia River flow. Also navigation is an increasingly important use with large volumes of barge traffic. Although the surface water area of this subregion is low in comparison to the regional area (table 24), there is a considerable amount of recreation use.

The climatic pattern is one of cool to cold winters and hot summers, with the major precipitation period from November to April. Yearly and diurnal temperature extremes are common during both the summer and winter months. Summer temperatures of over 100° F. commonly occur, especially in the plateau area adjacent to the Columbia River. In the mountain areas, winter temperatures of -30° F. to 40° F. have been recorded. Near the mouth of the Umatilla River, the average precipitation is only 7 inches, while at some locations along the Cascade Range on the west, the annual precipitation is over 130 inches. In the Blue Mountains on the east, the average precipitation is about 40 inches.

The Columbia Plateau is the predominant physiographic province, although the Blue Mountains and a high basalt plateau make up the southern section. The Columbia Plateau and the high basalt plateau are composed mostly of successive horizontal lava flows and old sediments capped by lava. In the latter area, composed of young lavas, there are many volcanic cones. The Blue Mountains are composed of granitic and metamorphic rock and tuffaceous sediments. This province is well-known for its abundance of agate and other semi-precious gem materials.

Accessibility, for the most part, is good. Interstate 80 crosses the northern section, connecting with eastern and western points. Highways 97 and 395 run north-south, the former paralleling the Cascade Range. Major railroads wind their way along both the north and south sides of the Columbia River and south up the Deschutes River. Multiple barge tows ply the slack waters of the Columbia, bringing in and taking out a great variety of raw materials and manufactured goods.

Employment concentrations in the primary and secondary sectors are in forestry and agriculture and food processing. The former has shown a significant decrease over the past 20 years, while the latter has more than doubled.

The 1965 population was 210,500, resulting in an overall density of about 7 people per square mile. Cities with more than 10,000 people are Bend, The Dalles, and Pendleton in Oregon; and Walla Walla in Washington. There are numerous smaller communities scattered throughout the subregion.

In summary, the Mid Columbia Subregion is a typical portion of the region lying between the Cascade Range and the Rocky Mountains. Most of the land use is livestock oriented, with more intensive use in limited areas. Certain areas are heavily used by recreationists, hunters, fishermen, and "rockhounds." The latter use is because this subregion is nationally known as containing one of the most abundant supplies of gem materials.

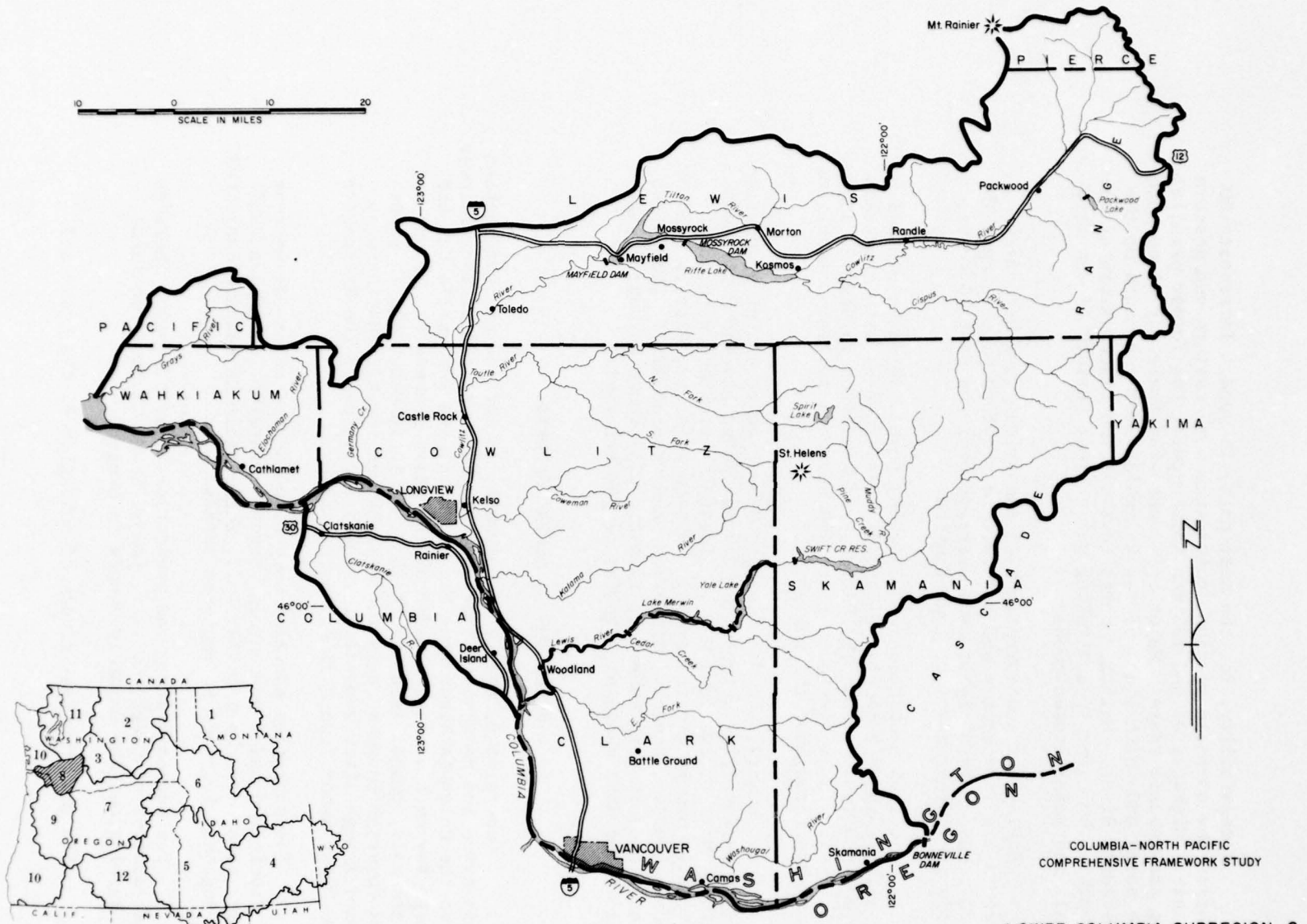
SUBREGION 8, LOWER COLUMBIA

Subregion 8, the Lower Columbia, is located in southwestern Washington and northwestern Oregon, and includes all of the drainage into the Columbia River from the north between Bonneville Dam and Grays Bay on the estuary and from the south between St. Helens and Clatskanie, Oregon (see figure 25). It is somewhat odd in shape and coverage because it is the residual of the Willamette-Puget Sound Trough after removal of the areas covered by the Willamette and Puget Sound Type 2 river basin studies.

The subregion contains only 5,103 square miles--94 percent in Washington and 6 percent in Oregon. Distribution of land and water areas are shown on table 27, while table 28 compares selected subregional features to regional totals.

For economic study and projections, the subregion includes the counties of Clark, Cowlitz, Lewis, Skamania, and Wahkiakum, in Washington; and Columbia County in Oregon.

The two principal rivers of Subregion 8, the Lewis and


Mt. Rainier
P I E R C E
10 0 10 20
SCALE IN MILES
122°00'
123°00'
L E W I S
Tilton River
Packwood
Packwood Lake
Mossyrock
Morton
Randle
MOSSYROCK DAM
Mayfield
MAYFIELD DAM
Riffe Lake
Kosmos
Cowlitz River
Cispus River
Toledo
P A C I F I C
Grays River
W A H K I A K U M
Lockaman River
Toutle River
N. Fork
Spirit Lake
Castle Rock
Germany Cr.
C O W L I T Z
S. Fork
St. Helens
Y A K I M A
Cathlamet
LONGVIEW
Kelso
Coweman River
Pine Creek
Muddy
Clatskanie
Clatskanie River
Rainier
SWIFT CR RES
Yale Lake
Malalma River
S K A M A N I A
Lake Merwin
46°00'
C O L U M B I A
Lewis River
Cedar Creek
Deer Island
Woodland
E. Fork
C A S C A D E R A N G E
C L A R K
Battle Ground
COLUMBIA RIVER
VANCOUVER
Washougal River
Skamania
BONNEVILLE DAM
Camas
W A S H I N G T O N
O R E G O N
CANADA
MONTANA
IDAHO
OREGON
CALIF
NEVADA
UTAH
WYO
LOCATION MAP
COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY
LOWER COLUMBIA SUBREGION 8
1968
FIGURE 25

Cowlitz, drain the western slopes of the Cascade. Glaciers tend to regulate these streamflows and cause the Cowlitz to be somewhat turbid the year around. Both rivers are used extensively for the generation of hydroelectric power. Main generating facilities are Mayfield and Mossy Rock Dams on the Cowlitz and Merwin, Yale, and Swift on the Lewis River. Other streams include the Kalama, Coweman, and Toutle Rivers in Washington. The Clatskanie River flows into the Columbia River from the south. The Columbia River, flowing across the southern border of the subregion, provides an excellent route for ships docking at Longview, Kalama, Vancouver, Rainier, and other ports.

Average annual runoff amounts to about 24,970 cfs, of which less than 1 percent is consumed within the subregion. About 588 cfs are withdrawn for consumptive uses, of which 27 cfs are for municipal, 512 cfs for self-supplied industry (the largest user), and 43 cfs for irrigation (the largest consumer). A significant percentage of the water is reused several times to generate hydroelectric power. Fish and wildlife using the streams have both recreational and commercial values.

Table 27 - Land & Water Areas, by State, Subregion 8, 1967 1/

State	Water Area		Land Area		Total Area	
	Sq.Mi.	Acres	Sq. Mi.	Acres	Sq.Mi.	Acres
Oregon	9.6	6,200	254.1	162,600	263.7	168,800
Washington	105.2	67,300	4,734.4	3,030,000	4,839.6	3,097,300
Total	114.8	73,500	4,988.5	3,192,600	5,103.3	3,266,100

1/ Data from Appendix IV, Land & Mineral Resources

Table 28 - Comparison of Subregion 8, Lower Columbia, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
1.8	3.7	1.8	8.1	4.0	35

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

Climatic conditions are similar to those of the Pacific Coast. Annual precipitation, 40 to 100 inches, falls mostly between November and April, with only light rainfall during the summer months. Temperatures are greatly modified by the ocean influence which reaches inland over the low Coast Range. Winter temperatures rarely fall below freezing for extended periods. Likewise, summer temperatures seldom exceed 90° F.

The Cascade Range, the subregion's eastern boundary, rises to an elevation of over 14,000 feet at Mt. Rainier. Elevations decrease westward to the Willamette-Puget Sound Trough, the major physiographic province. The Trough is typified by a series of valleys between low ridges. Surface rocks in this section are almost entirely marine sedimentaries with interspersed recent alluvial deposits. The Cascade Range is composed almost entirely of volcanic rocks. Some peaks have fairly recent lava flows on their flanks.

Accessibility is excellent. Interstate 5 crosses the subregion from north to south and U. S. Highway 30 parallels the Columbia River on the south bank. An excellent network of feeder roads serves all populated areas. The major railroad runs parallel to Interstate 5 and main lines extend from the Portland-Vancouver area through the Columbia Gorge to major population centers in the east.

The 40-foot navigation channel, now being developed on the lower Columbia River, will be adequate for all but the largest ocean vessels.

Over the past 20 years, employment in agriculture and forestry has decreased to about half its 1940 total. On the other hand, manufacturing employment has increased significantly, especially in the field of paper and allied products.

The 1965 census estimate showed a total population of 240,100 or 4.0 percent of the regional total. This results in a density of about 35 people per square mile, slightly above the regional average. The principal cities are Vancouver, Longview, and Kelso, all in Washington.

SUBREGION 9, WILLAMETTE

Subregion 9, the Willamette, lies entirely within the State of Oregon, occupying the Willamette and Sandy River drainages (figure 26). The Columbia River is the northern boundary, while the crest of the Cascade Range, the Coast Range, and the Calapooya Mountains make up eastern, western, and southern boundaries respectively.

The total area is 12,046 square miles or 4.4 percent of the regional area (table 29). The total land and water area is:

	Acres	Square Miles
Water Area	106,400	166.3
Land Area	7,602,800	11,879.4
Total Area	7,709,200	12,045.7

For economic studies and projections, the subregion includes the following counties: Benton, Clackamas, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill.

Table 29 - Comparison of Subregion 9, Willamette, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
4.4	5.7	4.4	12.4	22.8	102

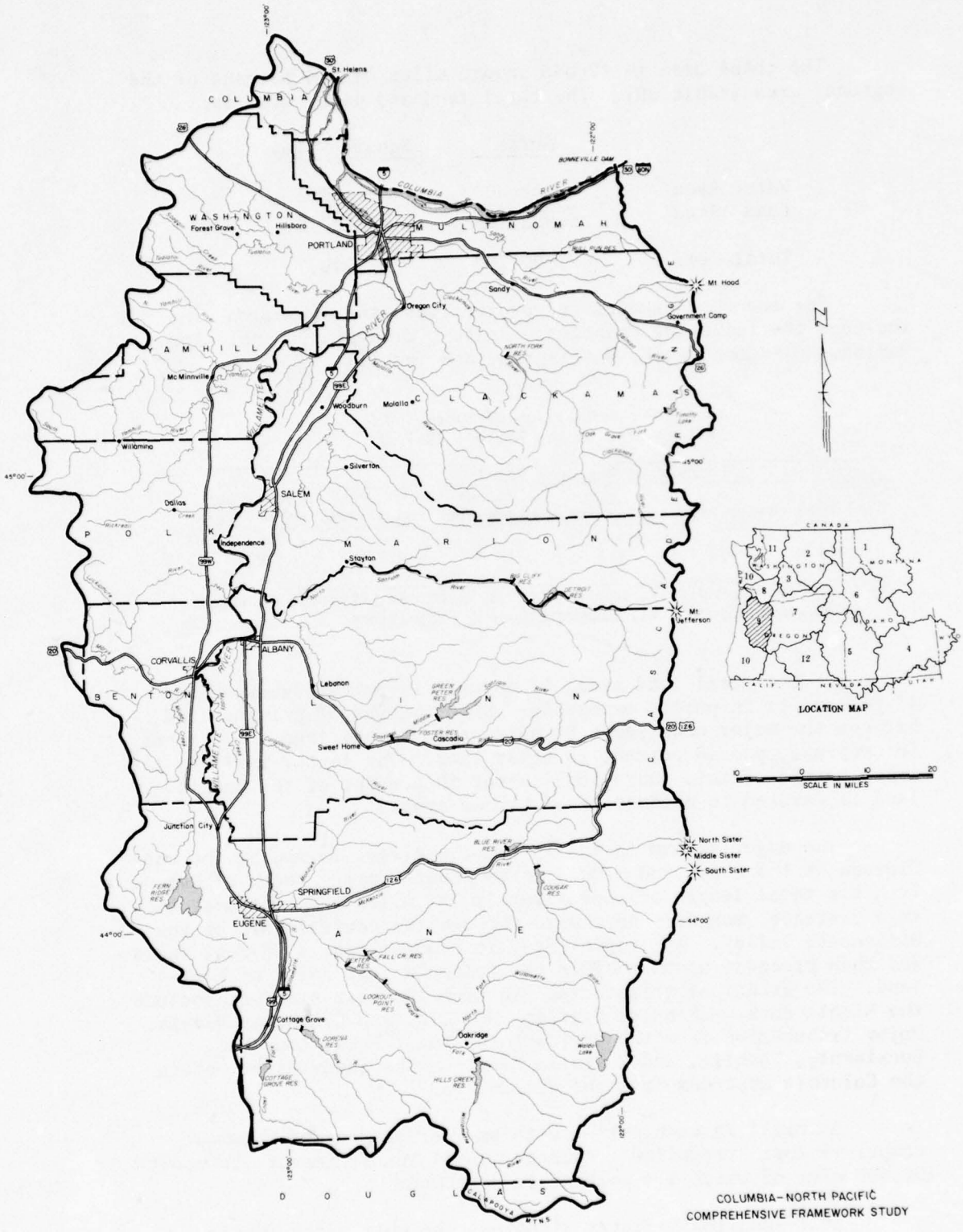
1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

Of the total land area, 57 percent is privately owned and 43 percent is in public ownership. Distribution of private land between the major uses shows 53 percent in forest land, 33 percent in cropland, and 13 percent in other land. The latter reflects the urban nature of this subregion. About 80 percent of the public land is devoted to production of timber crops.

The major stream is the Willamette River, formed by the confluence of the Coast and Middle Forks about 2 miles south of Eugene. It has a total length of approximately 187 miles and, for most of this distance, meanders northward through the central part of the Willamette Valley. At Oregon City, it plunges over a 50-foot falls and then proceeds north to join the Columbia just north of Portland. The principal tributaries are from the east side and include the Middle Fork, McKenzie, Santiam, Molalla, and Clackamas Rivers. Major tributaries from the west are the Coast Fork, Long Tom, Luckiamute, Yamhill, and Tualatin Rivers. The Sandy River enters the Columbia upstream from the Willamette.

Rainfall in combination with smaller amounts of snowmelt comprises most streamflow. Average annual runoff amounts to about 38,490 cfs, of which 1.4 percent is consumed.

Self-supplied industry withdraws the most water, while



COLUMBIA-NORTH PACIFIC
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WILLAMETTE SUBREGION 9

1968

FIGURE 26

irrigation is the second largest user and the largest consumer. Municipal and hydro-power generation are also important users. Ocean-going vessels use the Willamette River upstream to Portland. South of Portland, commercial navigation is limited to light barge traffic and log rafting. In addition, most of the rivers are used for recreation and produce game fish. Recreational use of water bodies is increasing in importance because of the subregion's rapidly increasing population.

There are eleven multiple-purpose reservoirs located on the major tributaries of the Willamette River--Detroit, Fern Ridge, Dorena, Lookout Point, Cottage Grove, Cougar, Hills Creek, Blue River, Foster, Green Peter, and Fall Creek are the major storage reservoirs. About half of these projects contain hydroelectric generating facilities. Private power developments are located on the main stem Willamette and on the Clackamas and Sandy Rivers.

The Willamette Subregion has dry, moderately warm summers, and wet mild winters. Average annual precipitation is 63 inches, of which 70 percent occurs during November through March and only 5 percent from June through August. Average annual precipitation ranges from more than 200 inches over small areas near the crest of the Coast Range, to less than 40 inches near the center of the valley, to more than 140 inches on portions of the Cascade Range. Average temperature at the lower levels ranges from about 40° F. during January to 67° F. during July. Temperatures rarely drop below zero and seldom exceed 100° F. At 2,000 feet elevation, snowfall is about 10 percent of the precipitation. At 8,000 feet, it is about 75 percent of the total. Snow accumulates all winter at the higher elevations in the Cascades, but rarely for more than a few weeks at a time below 3,000 feet.

The main river course and associated valley floor is located slightly west of the center of the subregion, with rolling foothills sloping up to mountainous terrain on the east, south, and west. The valley floor covers an area of approximately 3,500 square miles below 500-foot elevation, and extends from the vicinity of Eugene north to the Columbia River. It consists of a sloping alluvial plain broken by local ridges, buttes, and rolling hills. A range of basaltic hills crosses the northern end of the subregion near Oregon City constricting the river and valley. Most of the rocks are sediments, with buttes of basalt. The Coast Range to the west rises to an elevation of slightly more than 4,000 feet at Mary's Peak, but, in general, is less than 2,000 feet. The principal rock types are marine sediments interspersed with scattered lava flows. The Cascade Range is composed of volcanic cones and flows, some of fairly recent origin. There are several peaks in this range. The highest, Mount Hood, is 11,235 feet in elevation.

There are several railroads which connect the major cities

and principal lumber-producing centers to the nationwide system. All cities can be reached by highways which connect to the Interstate system. Interstate 80N leads from Portland to the east, through the Columbia Gorge. Interstate 5 crosses the Columbia River at Portland and extends south through the central part of the area. Several major airlines serve the subregion through facilities at Portland International Airport; however, commercial air service is also available at Salem, Corvallis, and Eugene. Ocean shipping is centered at the Portland docks, where large quantities of lumber, grain, and manufactured products are exported.

Although employment is concentrated in tertiary activities, manufacturing employment has been increasing rapidly in the past 20 years. Food processing, paper production, and primary metal manufacturing have all shown significant growth trends. Primary activities such as agriculture and forestry, although still an important segment of total employment, have shown some decline during the same period.

This is the second most populated subregion, with a 1965 population of about 1.4 million. This results in an overall density of 105 people per square mile. The major concentration is in the Portland Metropolitan Area, with additional concentrations at Salem and Eugene, all now considered SMSA's by the Census Bureau. There are many other cities and towns scattered throughout the valley.

Although the second most populated subregion, the Willamette Valley is an important producer of agricultural and timber products. It is also growing in importance in the production of electronic equipment and other manufactured goods, as well as being the economic and educational center of Oregon. In summary, this subregion can be considered to exhibit great contrasts, with highly populated urban areas and heavily used industrial areas adjacent to extensive farm lands.

SUBREGION 10, COASTAL

Subregion 10 extends from the southern border of Oregon to the northern tip of the Olympic Peninsula in Washington, a distance of over 400 miles. It includes the drainage areas of all streams, except the Columbia, which flow directly into the Pacific Ocean, the Columbia estuary or the Strait of Juan de Fuca west of Elwha River. The subregion extends inland to include all of the Chehalis, Umpqua, and Rogue River drainages, which provide marked contrast to the Coastal areas.

The total area of Subregion 10 is 23,763 square miles, or 8.7 percent of the regional area. Some 73 percent of the subregion is in Oregon and 27 percent in Washington. Table 30 shows the area

Table 30 - Land & Water Areas, by State, Subregion 10, 1967 1/

State	Water Area		Land Area		Total Area	
	Sq. Mi.	Acres	Sq. Mi.	Acres	Sq. Mi.	Acres
Oregon	130.3	83,400	17,163.2	10,984,500	17,293.5	11,067,900
Washington	111.0	71,000	6,358.9	4,069,700	6,469.9	4,140,700
Total	241.3	154,400	23,522.1	15,054,200	23,763.4	15,208,600

1/ Data from Appendix IV, Land & Mineral Resources

Table 31 - Comparison of Subregion 10, Coastal, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
8.6	8.0	8.6	28.2	6.9	22

1/ Data from Appendix IV, Land & Mineral Resources

distribution by States, while table 31 compares the subregion to the regional total.

For economic studies and projections, it includes the counties of Clatsop, Coos, Curry, Douglas, Jackson, Josephine, Lincoln, and Tillamook in Oregon, and Grays Harbor and Pacific in Washington.

About the only common feature of the basins in this subregion is that they drain directly into the ocean or other tidewater. The major streams include the Hoh, Quillayute-Soleduck, Queets, Quinault, Humptulips, Chehalis, and North Rivers in Washington; and the Nehalem, Wilson, Trask, Tillamook, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, Rogue, and Chetco Rivers in Oregon. Small perennial streams abound because of the high annual precipitation; however, their summer flow is low due to prolonged rainless periods. Along the coast are many easily accessible lakes, mostly small but significant for recreational use.

Average annual runoff amounts to about 83,500 cfs or about 28.2 percent of the regional total. Of the total, about 1.2 percent is withdrawn for consumptive uses, but less than 1 percent was actually consumed. The largest user is self-supplied industry, with irrigation second, followed by public supplies. Except on

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COASTAL SUBREGION 10

1968

FIGURE 27

the Rogue and Umpqua Rivers, only a small amount of water is utilized for the generation of hydroelectric power. Commercial navigation is served by the Columbia estuary and several harbors along the coast of both Washington and Oregon. Recreational use, especially boating, has been increasing rapidly on those waters adjacent to the population centers of the Willamette-Puget Sound Trough. Salt water sport fishing is a major attraction and is available along the entire coast through the thousands of private and charter boats operating out of the numerous estuaries. Sport fishing in the streams and estuaries for salmon and trout is important and becoming more so each year.

Major impoundments in this subregion include Lost Creek and Emigrant Reservoirs on the Rogue River system. In addition, there are a number of small power reservoirs in the Umpqua and Rogue River Basins.

About half of the 15.2 million acres in the subregion are in private ownership. Of this, some 13.8 million acres are in forest cover and only slightly over 500,000 acres are developed cropland. Approximately 50 percent of the forest land is also in private ownership, the remainder being mostly Federal.

An outstanding feature of the coastal area is the mild, moist climate. The inland areas of the Rogue, Umpqua, and Chehalis Rivers have considerably more variable climate which is drier and warmer. The coastal fringe has a small temperature range with extremes rarely occurring. Average annual precipitation generally ranges from 60 to 200 inches, most of which falls in the form of rain from November through March, with little rainfall in July or August. The interior valleys of southern Oregon have experienced minimum winter temperatures of zero degrees and summer maximum temperatures of 110° F. Precipitation totals range from 20 to 50 inches. Although significantly less than the coast, the same general rainfall pattern is evident.

Hilly to mountainous terrain is continuous from the Olympic Mountains south to the Klamath Mountains. About one-half of the snow-capped Olympic Mountains and the Coast Range are in subregion 10, plus part of the southern Cascade Range and a portion of the Klamath Mountains. Elevation ranges from sea level along the almost 500 miles of coastland to 9,495 feet on Mount McLoughlin in the southern part of the subregion.

Valleys are usually narrow, widening only within a few miles of the Pacific Ocean. The Rogue, Umpqua, and Chehalis Valleys are exceptions; they drain the west flanks of the Cascade Range, forming wide flood plains between the Cascade and Coast Ranges, then cut a narrow pathway to the ocean.

Metamorphosed and marine sediments are the dominant rock types of the Olympic and Klamath Mountains and the Coast Range, while the Cascade Range is composed almost entirely of volcanics.

The major highway (U.S. 101) closely follows the coast line with connections to interior parts of Oregon and Washington via several highways. There is only a small amount of railroad mileage and commercial airline service is limited to the major cities.

Although employment in the primary sectors of agriculture and forestry has decreased over the past several years, the decrease has not been as significant as in most subregions. The most rapid growth has occurred in the manufacture of paper and allied products.

The total 1965 population was 405,500. The settlement pattern is one of small towns generally located in the valleys near the coast. The large towns, except those of the interior, are located on the major bays and include Coos Bay, Newport, and Astoria in Oregon; and Aberdeen and Hoquiam in Washington. Inland cities are Grants Pass, Medford, and Roseburg, Oregon; and Chehalis and Centralia, Washington. The overall population density (table 31) is 16 people per square mile, or slightly below the regional average of 20.

Forests, lumber mills, and lumber products are readily noticeable features of the Coastal Subregion. Forest land covers about 90 percent of the land area; although a considerable portion of this forest has been cut over, reforestation will insure continued future harvest of timber.

SUBREGION 11, PUGET SOUND

Subregion 11 lies entirely within the State of Washington and includes all of the area south of the international boundary that drains into the Puget Sound, Hood Canal, Georgia Strait, and that part of the Strait of Juan de Fuca east from and including the Elwha River, as shown in figure 28. The area is bounded on the north by Canada, on the east by the Cascade Range, on the west by the Olympic Mountains, and on the south by a range of low hills. It covers 13,355 square miles, slightly less than 5 percent of the Columbia-North Pacific Region. Land and water areas are shown below, and the comparison of the subregion to regional totals is shown in Table 32. In addition there are about 2,500 square miles of salt water within the subregion boundaries. Subregion 11 encompasses the same area as the Type 2 comprehensive water resources study of the Puget Sound and Adjacent Waters.

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COMPREHENSIVE FRAMEWORK STUDY

PUGET SOUND SUBREGION II

1968

FIGURE 28

	Acres	Square Miles
Land Area	8,446,600	13,197.8
Water Area	100,600	157.2
Total Area	8,547,200	13,355.0

For economic study and projections, the subregion includes the counties of Clallam, Island, Jefferson, King, Kitsap, Mason, Pierce, San Juan, Skagit, Snohomish, Thurston, and Whatcom.

Table 32 - Comparison of Subregion 11, Puget Sound, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
4.8	5.2	4.8	16.8	32.4	121

1/ Data from Appendix IV, Land & Mineral Resources: Appendix V, Water Resources; Appendix VI, Economic Base & Projections

The ownership pattern of the subregion is such that about half (52 percent) of the land is in public ownership and half (48 percent) in private land. Eighty-one percent of the public land is forest land and 18 percent is in "other" land uses. Private land follows much the same pattern, with 71 percent in forest land, 14 percent in cropland, and 14 percent in "other" land. Public ownership predominates in the upper elevations, while the lowlands are almost entirely privately owned.

The principal rivers draining the north and east slopes of the Olympic Mountains are the Elwha and Skokomish. One stream, the Dungeness River, discharges only about one-third as much water per square mile as adjacent streams because it lies in the rain shadow of the Olympic Mountains. The principal rivers draining the western slopes of the Cascade Range are the Nisqually, Puyallup, Green, Cedar, Snohomish, Stillaguamish, Skagit, and Nooksack. Some of these rivers originate in the glaciers of the higher mountains. These glaciers tend to regulate streamflow by accumulating and storing precipitation during cold, wet years and releasing more than average amounts of water during hot, dry years. Additional water bodies include Puget Sound and nearly 2,000 fresh water lakes.

Average annual runoff amounts to about 53,100 cfs, of which about 1,000 cfs originate in Canada. The average discharge is the highest of all subregions. About 2.5 percent of the mean discharge is withdrawn for consumptive uses, but less than 1 percent is actually consumed. Nearly one-half of the water withdrawn is for

public supplies. The next largest user is self-supplied industry. Irrigation makes a minor withdrawal, but is the major consumer. Several rivers are utilized for electric power production, and the lower reaches of most larger streams are developed for navigation purposes. Recreation is a rapidly expanding use, especially on lakes and streams near the population centers. Most lakes and rivers are used by fish and wildlife.

There are 20 reservoirs of 5,000 or more acre-feet of storage capacity. The largest of these is Ross Lake on the Skagit River, with a total capacity of some 1.4 million acre-feet. The principal use of this facility is for power production and flood control. Other major reservoirs include Cushman on the Skykomish, Baker Lake and Lake Shannon on the Baker River, and Alder Lake on the Nisqually River. Power production, flood control, and recreation are the major uses of these reservoirs.

The climate of this subregion is greatly influenced by the maritime air masses which originate over the Pacific Ocean, moderating both winter and summer conditions. Although the precipitation totals show significant differences between different sections of the subregion, the general pattern is the same. Almost 75 percent of the total precipitation falls from October through March, while July and August precipitation is less than 5 percent of the total. The rain shadow on the eastward side of the Olympic Mountains receives less than 30 inches annually, with small areas getting less than 20 inches, while a short distance to the west and east upwards of 200 inches fall annually. Summer temperatures of 70° F. are common in areas adjacent to the Sound; valleys further inland reach 85° to 90° F. Extremes of 95° to 100° F. occur only five to fifteen days annually. High winter temperatures are usually in the 35° to 45° F. range, while lows are from 25° to 35° F. Temperatures of zero degrees have occurred at many stations, but are not common. Colder temperatures are recorded in the adjacent highland areas.

There are several physiographic divisions in the subregion. The central feature is Puget Sound lying in a broad north-trending structural trough flanked by mountain ranges. As the mountains were eroded to their present relief, the resulting sediments accumulated in the trough. During the glacial periods, several episodes of volcanic activities formed the major mountain peaks (Mt. Baker, Mt. Rainier, and Glacier Peak) of the Cascade Range. Characteristics of the present post-glacial terrain are the numerous lakes and swales, deranged drainages, and broad, deeply incised valleys. The valley floor sediments are post-glacial alluvial deposits associated with flood plains and deltas of the modern drainage system.

Several major highways pass through the Puget Sound

Subregion. Interstate 5 traverses it from north to south, allowing ready access to and from Vancouver, B.C. and the Willamette Valley in Oregon. Interstate 90 connects Seattle to the area east of the Cascade Range. Roads radiate out from the major highways to reach all sections of the subregion. Four transcontinental railroads serve the area, three of which cross the Cascade Range and terminate in the Seattle area. The fourth provides north-south connections. The tidal waters of Puget Sound not only provide good harbors for ocean-going ships, but are used extensively by pleasure craft. The largest air terminal in the region, the Seattle-Tacoma International Airport, is located in this subregion and provides worldwide connections.

Employment in the past several decades has shifted from a dependence on natural resources to a more diversified commercial and industrial base. Concentration of primary and secondary employment sectors is in manufacturing, with an important segment of this employment in the aircraft industry. Other concentrations are in food processing, primary metals, machinery, pulp and paper, and petroleum refining.

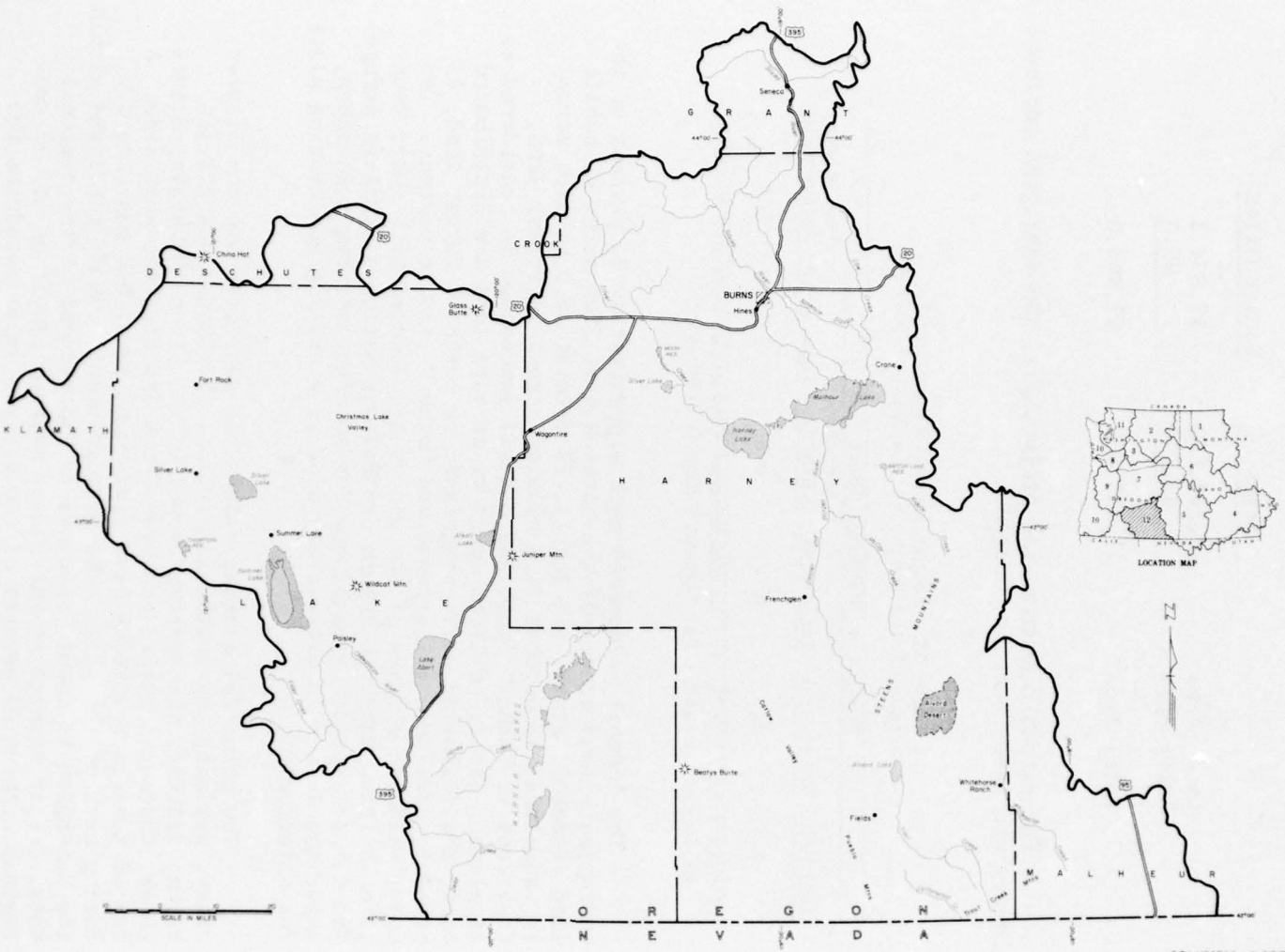
The Puget Sound Subregion is the most populous in the Columbia-North Pacific Region, with about 1.9 million people in 1965 or about one-third of the regional total (see table 30). The urban aspect of this subregion is readily apparent. It has the highest average density, with 121 people per square mile, the highest number of urban residents, and two of the region's largest cities--Seattle and Tacoma. Other large cities include Olympia, Bellingham, Bremerton, and Everett, plus several rapidly growing metropolitan communities surrounding Seattle and Tacoma.

Fort Lewis, one of the Nation's largest Army training centers, and McChord, a major west coast Air Force Base, are located a few miles south of Tacoma.

The Puget Sound Subregion is an urban and industrial complex, surrounded on three sides by lands that are virtually vacant and on the fourth by water. This water, the Puget Sound, provides a pathway for excellent contact to the rest of the world, in addition to being a central feature in the recreation activity of the subregion. The Puget Sound is recognized as the "boat capital" of the United States, with the highest per capita boat ownership, and an active participation in the various water-oriented sports.

SUBREGION 12, OREGON CLOSED BASIN

Subregion 12 is located entirely within the State of Oregon and consists of the northern extension of the Basin and Range Province into Oregon, a large area without external drainage.



COLUMBIA-NORTH PACIFIC
COMPREHENSIVE FRAMEWORK STUDY

OREGON CLOSED BASIN
SUBREGION 12

1968

FIGURE 29

Figure 29 shows the location of the subregion within the region. The total area is 17,904 square miles, as shown below, or 6.5 percent of the regional area (table 33).

	Acres	Square Miles
Land Area	11,394,800	17,804.3
Water Area	63,500	99.3
Total Area	11,458,300	17,903.6

For economic studies and projections, the subregion includes Harney and Lake Counties, Oregon.

Table 33 - Comparison of Subregion 12, Oregon Closed Basin, to the Region, 1967 1/

Percent of Regional Total					
Land Area	Water Area	Total Area	Average Discharge	Population	People per Square Mile
6.5	3.3	6.5	0.5	0.1	0.7

1/ Data from Appendix IV, Land & Mineral Resources; Appendix V, Water Resources; Appendix VI, Economic Base & Projections

The Federal Government owns approximately 73 percent of the subregion's land area. Of the total 8.6 million acres of public land (Federal, State, and local), 79 percent (6.9 million acres) is rangeland, 18 percent (1.5 million acres) is forest land, 2 percent is "other" land, and a small percentage is considered as cropland. The 2.7 million acres of private land are distributed among the following uses--rangeland, 68 percent; forest land, 13 percent; cropland, 13 percent; and "other" land, 6 percent. Two major wildlife refuges of the region are located here--Hart Mountain National Antelope Refuge and Malheur National Wildlife Refuge. The former provides a sanctuary for antelope and Big Horn sheep, while the latter is extensively used as a nesting and resting place for waterfowl.

The principal streams within the subregion are the Silvies River, draining the northeast portion; the Donner und Blitzen River, draining the western slopes of the Steens Mountain; Silver Creek, Chewaucan River, and Deep Creek draining the west side. A few of the minor streams have year-round flow, but most are dry during much of the year. The average annual runoff generated within the subregion is about 1,650 cfs or 0.5 percent of the regional total. This results in the lowest average runoff of all 12 subregions. About 92 percent of the surface water withdrawn for

consumptive use is for irrigation. The other important use is self-supplied industry.

Most waters are used to some extent for fish, wildlife, and recreation. Thompson Reservoir, located on Silver Creek and having a total capacity of 21,500 acre-feet, is the only reservoir in the subregion with a storage capacity of 1,000 acre-feet or more. Its waters are used almost entirely for irrigation. All drainages flow into large internal brackish lakes and playas. Of the many lakes, Summer, Abert, Harney, Crump, Hart, Flagstaff, Campbell, Bluejoint, Silver, and Malheur are permanent, although their total storage fluctuates considerably from year to year and some may even dry up in periods of draught. During the Pleistocene Epoch, these lakes were larger and remnants of ancient shorelines can still be found at elevations well above the present shoreline.

The Oregon Closed Basin has no truly frost-free season, as frosts can occur during any month of the year. High annual and diurnal temperature ranges are recorded at all stations. Extremes of from -50° F. to 107° F. have occurred. Diurnal temperatures commonly fluctuate 50 degrees during the summer months. Precipitation totals range from 6 to 30 inches, depending upon the location with respect to rainshadows and elevations. Despite the high average elevation, precipitation falls as snow only 40 percent of the time.

As an extension of the Great Basin, the Oregon Closed Basin has many of its prominent features such as fault block mountains and graben valleys. Elevations range from just under 4,000 feet to nearly 10,000 feet on the Steens Mountain. The entire area is covered with lava flows which can readily be seen on the escarpments of mountains such as the Steens and Abert Rim. Most lavas of the lower flat lying areas are covered by old lake sediments and recent alluvium.

U. S. Highways 20 and 395 cross this subregion; the former from east to west, and the latter from north to south. State highways and gravelled roads serve the remainder of the subregion. The only railroad connects Burns to the Snake River Valley. There is no scheduled airline service.

In contrast to most subregions, primary and secondary employment make up almost one-half of the total employment. Over 90 percent of the manufacturing employment is in the production of forest products. Total employment actually shows a decline between 1950 and 1960.

With a 1965 population of only 13,300, this subregion is by far the least densely populated. The approximately 0.7 people per square mile results in less than 0.1 percent of the region's

total population. The only urban communities are Burns and Hines in northern Harney County. There are several small settlements scattered across the subregion.

BIBLIOGRAPHY

1. Batelle Memorial Institute, The Pacific Northwest, a Study of Economic Growth in a Quality Environment, December 1967.

2. Craig, Joseph A., and Robert L. Hacker. 1940, The History and Development of the Fisheries of the Columbia River, United States Department of the Interior, Bulletin of the Bureau of Fisheries 49: 133-216.

3. Highsmith, Richard M., Jr., Editor, Atlas of the Pacific Northwest, Oregon State University Press, Corvallis, Oregon, 1962.

4. Johansen, D. O. & C. M. Gates, Empire of the Columbia, a History of the Pacific Northwest, Harper & Brothers, New York, 1957.

5. Maximum Grant Rates for Public Works Grants in Qualified Areas Under the Public Work & Economic Development Act of 1965, Public Law 89-136, United States Department of Commerce, Washington, D. C., January 31, 1969.

6. Meier, M. F., Distribution & Variation of Glaciers in the United States, Exclusive of Alaska, International Association of Scientific Hydrologists, Publication No. 54, 1960.

7. The Columbia River, House Document 473, 81st Congress, 2nd Session, The Upper Snake, Page 115.

8. Walker, A. L., et al, The Economic Significance of Columbia Basin Project Development, College of Agriculture, Washington State University, Pullman Experiment Station, Bulletin 669, September 1966.

PARTICIPATING STATES AND AGENCIES

STATES

Idaho	Nevada	Utah	Wyoming
Montana	Oregon	Washington	

FEDERAL AGENCIES

Department of Agriculture
- Economic Research Service
- Forest Service
- Soil Conservation

Department of the Army
- Corps of Engineers

Department of Commerce
- Economic Development Administration
- Weather Bureau

Dept. of Health, Education, & Welfare
- Public Health Service

Dept. of Housing & Urban Development

Dept. of Transportation

Department of the Interior
- Bonneville Power Administration
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Mines
- Bureau of Outdoor Recreation
- Bureau of Reclamation
- Fed. Water Pollution Control Adm.
- Fish and Wildlife Service
- Geological Survey
- National Park Service

Department of Labor

Federal Power Commission